# Forest Health Strategy

**Nadina District 2016-2017**

BRITISH COLUMBIA

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# PREAMBLE

This Forest Health Strategy (FHS) reports pest impacts on forest resources within the Nadina District (Skeena Region). It recommends forest practices and management actions that accommodate known forest health risks in order to ensure adequate resource protection. It is important to recognize that these recommendations are management guidelines and that site specific alterations must be made when required.

This document is intended to address both immediate and long-term forest health issues in the Nadina District. Immediate forest health issues are those that can impact a stand during the establishment phase. The resulting damage is apparent during subsequent free growing assessments. Minimum densities are set for stands at free-growing which typically occurs at age 15 or earlier. These minimum density thresholds have been based primarily on immediate forest health issues. Long-term forest health issues are those where damage may not be readily identifiable at the time of free growing declaration, but have the potential to impact through the rotation. The fundamental principles of growth and yield which are at the basis of all growth and yield models assume that forest disturbances which attack larger crop trees, particularly mid-rotation, are rare exceptions. TIPSY and therefore TSR assume relatively stable densities of crop trees after age 15. To be consistent with TSR assumptions managed stands at age 25-30 should still have close to (± 5%) the same well-spaced density as they had at free-growing. It is essential that both immediate and long term forest health issues are considered in setting density targets.

Under the professional reliance model, it is incumbent on resource professionals to consider science-based findings and other information in making recommendations and decisions. Therefore, it is critical that forest professionals consider the forest health factors that may be present on a site during stand establishment and those that can reasonably be expected at a later stage of stand development.[1]

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[1] Sutherland, Jim. Guidance for assessing FSP stocking standards alignment with addressing immediate and long-term forest health issues. June 21, 2012 Memo.
https://www.for.gov.bc.ca/hfp/silviculture/Guidance%20for%20assessing%20FSP%20stocking%20standards%20June%2021%202012.pdf

# 1.0 INTRODUCTION

## 1.1 Goals and Objectives

Forest health agents can prevent stands from reaching management objectives by increasing tree mortality, causing deformities or suppressing growth rates. Any of these impacts can result in significant reductions in stand volumes.

The Forest Health Strategy for the Nadina District includes a general section for forest health agents other than bark beetles and a section dedicated to bark beetles. Both are consistent with the priorities and objectives of the Provincial Forest Health Strategy[i] and the Provincial Bark Beetle Management Technical Implementation Guidelines[ii].

The goal of the Nadina Forest Health strategy is to increase awareness of local forest pests and their impacts and to guide forest management practices on Crown land within the Lakes and Morice Timber Supply Areas (TSAs). The practices recommended in this document are based on professional judgement supported by science and are designed to minimize the risk of significant pest damage to both managed and unmanaged stands.

To successfully attain this goal, a number of objectives must be achieved:

- Maintain detection and reporting programs;
- Produce incidence maps as a tool for assessing current impacts at stand and landscape levels;
- Identify new pest risks to resource values in the context of climate change;
- Implement strategies and tactics according to scientifically sound practices; and
- Continue to improve management practices.

## 1.2 Background

A forest health strategy is required for each TSA in the province. These strategies provide guidance and/or best management practices with regards to forest health factors and issues present in each TSA. It is important that professionals consider this information during planning and operational activities. Although the forest health strategy is not a legally-binding document, it provides information to guide specific forest management activities such as the development of stocking standards, stand tending activities and landscape-level species selection.

The implementation of this Forest Health Strategy could stabilize and augment the timber supply of the Lakes and Morice TSAs by increasing the success of regeneration practices, increasing the productivity of immature stands, and decreasing losses of mature timber. These benefits imply a reduced risk to silviculture investment and a more stable planning environment, both of which are important to the Ministry of Forests, Lands and Natural Resource Operations and the forest industry. The early detection of forest health problems and

the prompt application of scientifically sound solutions will allow forest managers to take full advantage of potential benefits.

Managing for species diversity in regenerating stands is one the most effective means of reducing the risks associated with any one forest health factor. In light of climate change, the mountain pine beetle (MPB) epidemic, and increasing damage to plantations due to hard pine rusts, Dothistroma foliar disease, root collar weevil, and others, it is more important than ever to maximize species diversity in managed stands to maintain a long-term supply of commercially valuable timber.

### 1.3 Private Land Owners/Woodlot Licensees

This Forest Health Strategy is intended to guide management of Crown land within the Nadina District. For private land owners and woodlot licensees, forest health responsibilities are limited; however, it would be in the best interest of these tenure holders to consider and implement this strategy as it applies and is needed. Generally, the results of aerial surveys are available to support private land owners and woodlot licensees and is collected and summarized on an annual basis at http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/aerial-overview-surveys/summary-reports

### 1.4 Budget

In the Nadina District, the implementation of bark beetle suppression activities (limited to spruce beetle and Douglas-fir bark beetle) and other pest monitoring/treatment programs will depend on funding availability and priority ranking through the Land Base Investment Strategy (LBIS) account.

### 1.5 Stand Development Monitoring (SDM) Results

Stand Development Monitoring measures the health and productivity of young even aged stands between the ages of 15 and 40 years. The key objectives of SDM are to: 1) assess the health and productivity of young stands; 2) review the effectiveness of government policies and forest management practices that govern stand initiation, resource sustainability and risk to the Crown; and 3) to develop in-house expertise within the Ministry regarding the health and productivity of managed stands.

Since 2010, 72 polygons have been assessed in the Nadina District. The key findings[2] show that stocking densities decreased significantly in the 12 years (on average) separating the free-growing declaration and the SDM survey. The SDM survey results show that a significant proportion of the sampled stands (60%) now have a well-spaced density below 1000 stems per hectare. Pine dominates the sampled stands and a significant portion of these stands are affected by hard pine rust.

[2] FREP survey results can be found at: http://www.for.gov.bc.ca/ftp/DND/external/!publish/Forest_Health

Current timber supply projections for the Nadina District assume an initial planting density of 1500 stems per hectare. According to TIPSY projections with this initial planting density, well-spaced densities should vary by about 18% between year 15 and year 90 and 30 years old stands should have well-spaced densities of about 1050 stems per hectares. TIPSY projections for typical pine-leading stands also show that well-spaced densities after year 15 tends to be relatively stable, regardless of the initial planting densities. In contrast, SDM results show that the sampled stands had an average initial planting density of 1328 stems per hectare and an average well-spaced density of 974 stems per hectare at an average stand age of 24 years old. Consequently the sampled stands are not consistent with TSR assumptions as projected by TIPSY (Figure 1).

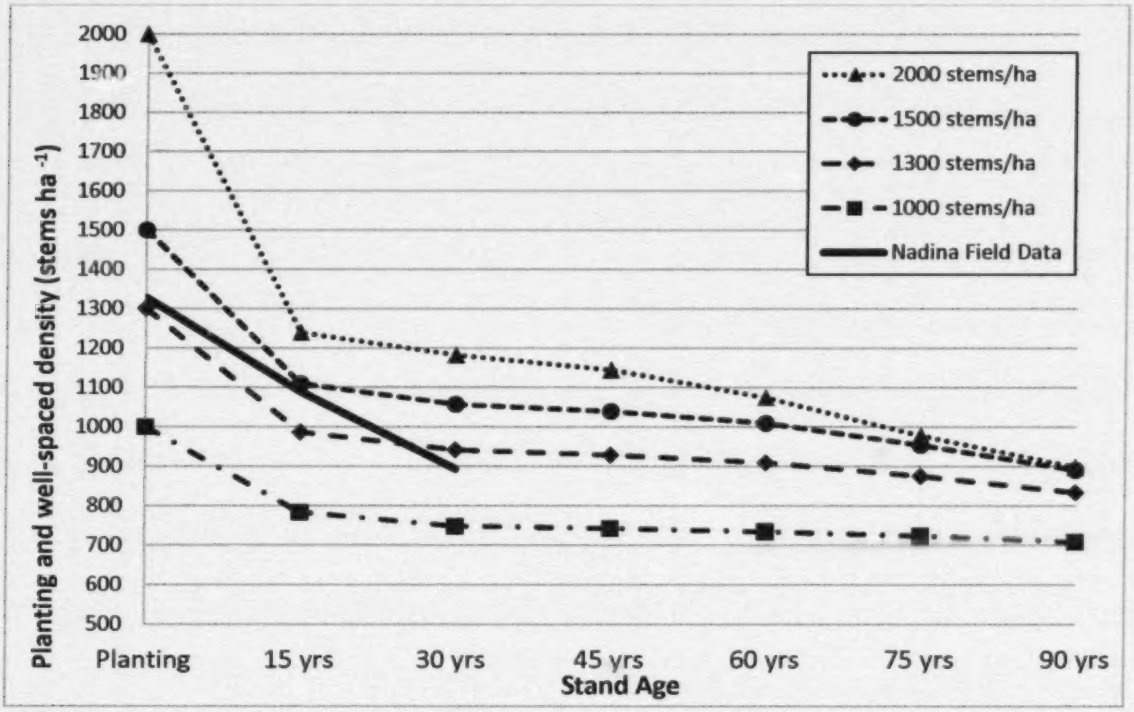



***Figure 1.*** *Comparison of Nadina SDM field data (solid line) to TIPSY modelled changes in managed stand density between planting and stand age 90 for initial planting densities of 1000, 1300, 1500 and 2000 sph.*

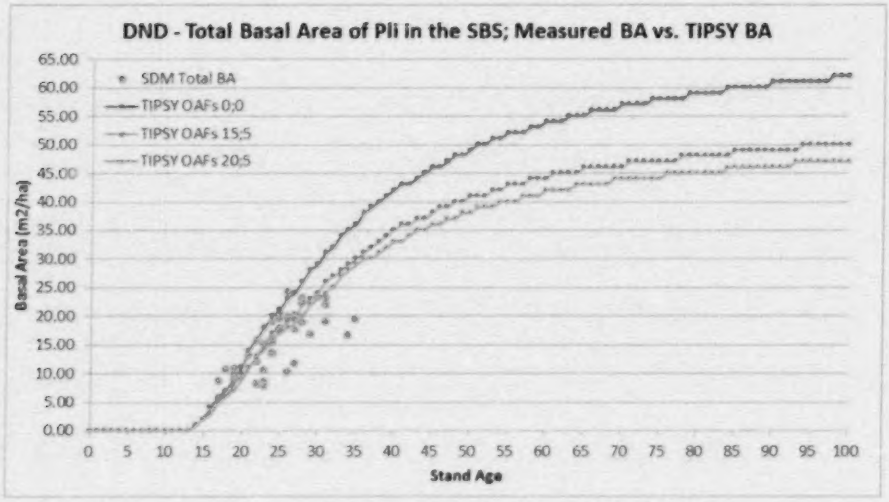
Forest health damage agents and initial planting densities are the primary reason for the deviation from projected stand trajectories. Hard pine rusts, vegetative competition and deformities caused by abiotic factors are the principal forest health agents affecting stands in the Nadina (Table 1).

| Observed forest Health Damage Nadina SDM 2010-2015 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Not present | Low | | Moderate | | High | | |
| Damage agent group | Number of Stands | Number of Stands | Threshold range(%) | Number of Stands | Threshold range(%) | Number of Stands | Threshold range(%) | Highest Incidence (%) |
| Hard Pine Rusts | 7 | 17 | < 10 | 18 | 10 to 20 | 20 | >20 | 60.8 |
| Vegetative Competition | 13 | 51 | < 10 | 4 | 10 to 20 | 4 | >20 | 47.7 |
| Other Abiotic Deformities | 9 | 62 | < 10 | 1 | 10 to 20 | | | 14.8 |
| Snow Damage | 24 | 45 | < 10 | 3 | 10 to 20 | | | 12.6 |
| Animals | 38 | 29 | < 10 | 5 | 10 to 20 | | | 17.5 |
| Treatment Injuries | 59 | 13 | < 10 | | | | | 7.1 |
| Warren's Root Collar Weevil | 61 | 11 | < 10 | | | | | 5.9 |
| Foliage Diseases | 70 | 2 | < 10 | | | | | 3.1 |
| Bark Beetles | 70 | 2 | < 10 | | | | | 1.2 |

***Table 1**. Number of Stands affected by forest health damage agent groups by incidence class across 72 sampled stands in Nadina District; data include the highest incidence values observed and the tally of stands where damage groups were not observed.*

The SDM survey results were also used to assess the combined impacts of forest health factors on the basal area of managed stands. For this assessment, the diameter at breast height (DBH) of all trees 7.5 cm and greater was measured and the health condition of individual trees was recorded. Stand age was determined based on the last harvest date shown in the history record. The measured basal area was then compared against generic TIPSY projections for lodgepole pine based on an initial planting density of 1500 stems per hectare and site index value of 20 metres (similar to the timber supply assumptions used in the Nadina District)(Figure 2).

The following graphs show the result of the comparison between the total basal area and generic TIPSY projections and between the healthy basal area and the generic TIPSY projections. In the first graph, total basal area includes all trees whether live or dead, healthy or unhealthy. In the bottom graph (Figure 2), healthy basal area includes only those trees that pass the SDM damage criteria **(Appendix 7)**. The largest contributor to basal area loss was hard pine rusts.


DND - Total Basal Area of Pli in the SBS; Measured BA vs. TIPSY BA
SDM Total BA
TIPSY OAFs 0;0
TIPSY OAFs 15;5
TIPSY OAFs 20;5
Basal Area (m2/ha)
Stand Age

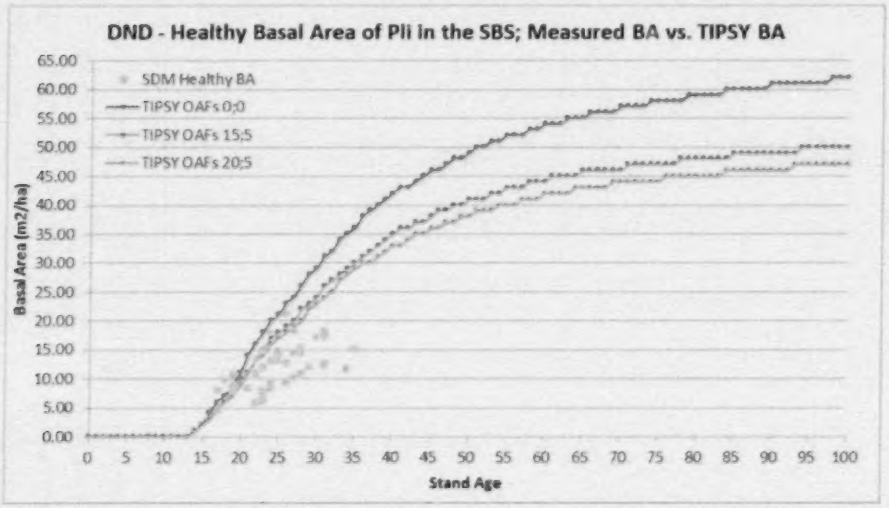

DND - Healthy Basal Area of Pli in the SBS; Measured BA vs. TIPSY BA
SDM Healthy BA
TIPSY OAFs 0;0
TIPSY OAFs 15;5
TIPSY OAFs 20;5
Basal Area (m2/ha)
Stand Age

***Figure 2**. Comparison of the mean total basal area (top) including all trees > 7.5 cm dbh (live and dead) measured using the SDM survey and the healthy BA which includes only the trees that pass the SDM damage criteria (bottom) and generic TIPSY projections based on initial planting densities of 1500 sph, site index 20m and three combinations of Operational Adjustment Factors (OAFs).*

Given the losses to forest health damage agents in the longer term, in order for managed pine stands in the Nadina District to follow projected productivity trajectories, it is recommended that the Nadina District Reference Guide for FSP Stocking Standards (see appendix 8) be adopted and more trees be planted at stand initiation.

## 2.0 GENERAL STRATEGY

This section identifies important forest health agents found in the Nadina District. Historically the most damaging pest in the Nadina District has been the mountain pine beetle. However, as the mountain pine beetle epidemic subsides, spruce bark beetle and hard pine rusts in managed stands pose an increased risk to timber supply. Pests that have a greater importance or occurrence throughout the District have been ranked (Table 2.1) based on the following considerations:

- The local knowledge of Regional and Provincial forest health specialists, Nadina District Staff and Licensees;
- Known or suspected impacts to forest resource values;
- Availability of resources to conduct operational detection and treatments;
- Costs and benefits of applying detailed detection and treatment activities;
- Overall level of knowledge about the hazard and risk zones, and
- Distribution of the agent and current incidence levels.

## 2.1 Ranking by Management Priority

**Table 2.1 – Ranking of Important Pests within the Lakes and Morice Timber Supply Areas**

| Forest health Agen[1] | Lakes TSA | | | | Morice TSA | | | |
|---|---|---|---|---|---|---|---|---|
| | Management priority (1) | Impact to timber supply known | Potential impact on forest values (2) | Management strategies available | Management priority (1) | Impact to timber supply known | Potential impact on forest values (2) | Management strategies available |
| Spruce bark beetle | VH | Yes | Severe | Yes | VH | Yes | Severe | Yes |
| Mountain pine beetle | H | Yes | Mod | Yes | H | Yes | Mod | Yes |
| Comandra blister rust | H | Yes | Mod | Yes | H | Yes | Mod | Yes |
| Western gall rust | H | Yes | Mod | Yes | H | Yes | Mod | Yes |
| Stalactiform blister rust | H | Yes | Low | Yes | H | Yes | Low | Yes |
| Western balsam bark beetle | L | Yes | Mod | Yes | M | Yes | Mod | Yes |
| Warren's root collar weevil | M | Yes | Low | Yes | M | Yes | Low | Yes |
| Pine needle cast (Lophodermella) | M | Yes | Low | No | M | Yes | Low | No |
| Phaeoseptoria contortae | M | Yes | Low | No | M | Yes | Low | No |
| 2 year cycle budworm | L | Yes | Mod | Yes | M | Yes | Mod | Yes |
| Dothistroma needle blight | L | Yes | Low | Yes | M | Yes | Mod | Yes |
| Rhizosphaera needle cast | L | No | Low | No | L | No | Low | No |
| Spruce leader weevil | L | Yes | Low | Yes | L | Yes | Low | Yes |
| Pine terminal weevil | L | No | Low | Yes | L | No | Low | Yes |
| Engraver beetle | L | No | Low | Yes | L | No | Low | Yes |
| Pityogenes spp | L | No | Low | No | L | No | Low | No |
| Lodgepole pine dwarf mistletoe | L | Yes | Low | Yes | L | Yes | Low | Yes |
| Rhizina root disease | L | Yes | Low | No | L | Yes | Low | No |
| Tomentosus root rot | L | Yes | Low | Yes | L | Yes | Mod | Yes |
| Schweinitzii Butt rot | L | Yes | Low | No | L | Yes | Low | No |
| Fomitopsis pinicola heart rot | L | Yes | Low | No | L | Yes | Low | No |
| Windthrow | L | Yes | Mod | No | L | Yes | Mod | No |
| Drought | L | No | Mod | Yes | L | No | Mod | Yes |
| Mammal damage | L | No | Low | No | L | No | Low | No |
| Douglas fir beetle | L | Yes | Low | Yes | | | | |
| Snow Press | L | No | Mod | No | L | No | Mod | No |

(1) Low, Moderate, High and Very High

(2) The 11 forest values identified in FRPA; Low, Moderate, High, Severe

## 2.2 Provincial Aerial Overview Survey

The Provincial Aerial Overview Survey (AOS) provides general data about the condition of our forests. **Table 2.2** below shows a listing of forest health agents found in the Nadina district, their current status, and a comparison with historical levels as identified from prior AOS's. This list consists of only forest health agents that can be identified from the high elevation that the AOS is conducted at, and is ground-truthed when funding and logistics are available. Note for bark beetle attack, only red attack is mapped and is expressed as a percentage of the whole stand.

Table 2.2– Historical comparison of forest health agents.

| | Forest Health Factor | 2015 DND (ha) | 2014 DND (ha) | 2013 DND (ha) | 2012 DND (ha) | 2011 DND (ha) | 2010 DND (ha) | 2009 DND (ha) | 2008 DND (ha) | 2007 DND (ha) | 2006 DND (ha) | 2005 DND (ha) | 2004 DND (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BARK BEETLES | IBM= Mountain Pine Beetle | 1,554 | 36,048 | 105,637 | 156,222 | 238,144 | 798,784 | 1,342,136 | 858,103 | 1,140,002 | 1,186,684 | 1,226,838 | 793,600 |
| | IBS= Spruce Bark Beetle | 3,934 | 3052 | 67 | 252 | 3 | 2 | | 1 | 1 | 1 | 1,940 | 320 |
| | IBB= W. Balsam Bark Beetle | 287,512 | 353,262 | 260,380 | 152,356 | 42,976 | 204,486 | 188,420 | 80,738 | 178,155 | 41,182 | 117,328 | 177,988 |
| | IBD= Douglas-fir beetle | 1 | 733 | 527 | 949 | 138 | | | | | | | |
| DEFOLIATORS | ID=Defoliators | | | | | 700 | 751 | 212 | | | | | |
| | IDB= 2 year budworm | 8,122 | 54 | 0 | 63 | 71,823 | 3,268 | 107,430 | | 7,469 | | | |
| | IDF= Forest Tent Catepillar | | 3937 | | | 3,321 | 82 | | | | | | |
| | IDX=Large Aspen Tortix | | | | | | | | 21 | | 205 | | |
| | ID6=Aspen Leaf Miner | 297,772 | 547,644 | 549,147 | 192,481 | 105,451 | 23,381 | 945 | 3 | | | | |
| | ID2= Bruce Spanworm | | | | | | 248 | | | | | | |
| OTHER | NB= Fire | 519 | 98,380 | 3,523 | 7,516 | 21 | 36,915 | 2,625 | 230 | | 75 | 1,072 | 3,070 |
| | NBP=Post Fire | 91,914 | 754 | 1687 | 240 | | | | | | | | |
| | NH=Hail | | | | 206 | | | | | | | | |
| | NW= Windthrow | 58 | 14 | | | | | | 136 | | 59 | 2,529 | |
| | NF= Flooding | 205 | 137 | 126 | 160 | 126 | 52 | 92 | 64 | 18 | 144 | 126 | 115 |
| | NS= Slide | | 15 | 16 | 10 | | 301 | 11 | | 7 | | | |
| | ND= Drought | | | | | | | | | | 64 | | |
| | AH=Hare | 363 | | 211 | | | | | | | | | |
| | AP=Porcupine | | | | | | | | | | | | 11 |
| DISEASE | DFL= Pine Needle Cast | | | | 181 | | 1,725 | 1,987 | 14,645 | | | | |
| | DLV= Venturia spp. | 1,131 | 45,915 | 6,736 | 41,298 | 33,164 | 82 | | | | | | 14,817 |
| | DSC= Commandra | 7,742 | | | | | | | | | | | |
| | DFS= Dothistroma | | | | | | | 256 | | | | | |

Source: Provincial overview flights

## 2.3 Strategies and Tactics for Priority Pests

The intent of this section is to outline strategies for reducing the risk of impacts arising from pests other than bark beetles. These strategies conform to the strategies addressed by the forest health guidebooks, Stand Establishment Decision Aids (SEDA's), Ministry of Forests, Lands and Natural Resources (MFLNRO) guidelines, and other relevant research findings. Strategies and tactics for bark beetles can be found in Section 3.0 (Bark Beetle Component).

### Pine Stem Rusts

***High priority***

Comandra Blister Rust - *Cronartium comandrae*

Stalactiform Blister Rust - *Cronartium coleosporioides*

Western Gall Rust - *Endocronartium harknessii*

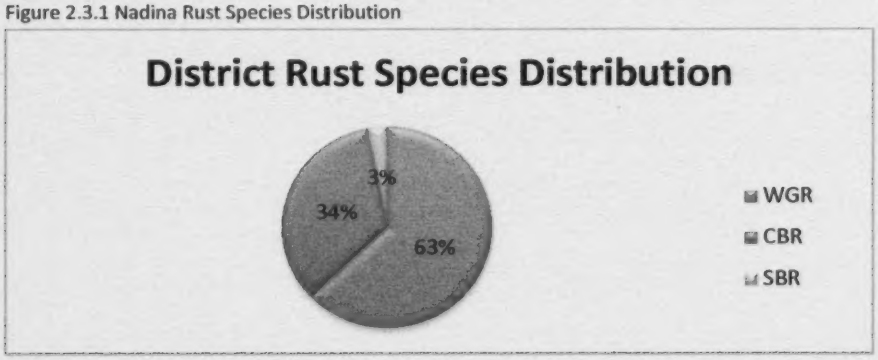
#### *Management Objective*

To reduce losses of volume and wood quality in young stands impacted by rusts which cause mortality, unacceptable stem damage, lower value logs and plantation failure.

#### *Ranking Rationale*

TSA scale maps have been created from RESULTS submissions, in-house sampling and FIA-funded forest health surveys and are located in **Appendix 1 and 2** to provide an overview of recorded rust occurrence. Rusts are ubiquitous throughout the Nadina District and are not limited to the areas depicted on the maps. Pine should be considered at high risk of infection in the entire District, especially within the SBS biogeoclimatic zone. As shown in **Figure 2.3.1**, the leading rust species across the Nadina District is western gall rust, followed by comandra blister rust and the much less common stalactiform blister rust.

Figure 2.3.1 Nadina Rust Species Distribution



*Lakes TSA*

Pine stem rusts are currently considered the most serious disease of managed stands in the Lakes TSA. The impact of rusts on stand productivity has previously been estimated at 7.2% (Woods et al, 2000). In 2011, a rust sampling project was conducted on 70 randomly selected, pine leading, age class 1 stands across the Lakes TSA. The results indicated that 99% of the stands had some level of rust present and that 43% of the stands were categorized as 'high' incidence, with >20% of the host trees affected. Western Gall Rust and Comandra Blister Rust were the most prevalent diseases. SDM results are similar with 94% of blocks sampled having rust present and 36% of those stands categorized as 'high' incidence. There appears to be no pattern of distribution and therefore the past strategies to manage pine according to areas of higher or lesser risk of infection **is no longer valid**. The TSA scale map in **Appendix 1** illustrates the ubiquitous nature of rusts throughout the landscape. Note that lodgepole pine stands in the ESSF biogeoclimatic zone still remain low in rust incidence.

*Morice TSA*

Pine stem rusts are a high priority forest health factor that can result in significant damage and mortality, particularly those stems in the seedling to pole-size range.

In 2008-2010, a rust sampling project was conducted on 124 randomly selected, pine leading, age class 1 stands across the Morice TSA. The results showed that 99% of the blocks had some level of incidence of rust and that 42% of the stands are categorized as 'high' incidence with >20% of the host trees affected. SDM results are somewhat lower with 86% of blocks sampled having rust present with 20% of those stands categorized as 'high' incidence. These findings were consistent with the results of Young Stand Monitoring (YSM) that indicate that 25 percent of sampled pine stems are infected with rust. The most prevalent rust disease was Western Gall Rust, followed by Comandra and Stalactiform. As in the Lakes TSA, rust has a low incidence in the ESSF biogeoclimatic zone. However, some pine plantations located in the ESSF are heavily impacted by rust (e.g. upper Buck Creek drainage).

The forest health survey results for the Nadina Natural Resource District and the YSM and SDM information all indicate that there is a high incidence of pine rusts in managed stands in the Morice TSA.

*Management Tactic*

- Avoid reforesting with 100% pine;
- Follow the Nadina District Reference Guide for FSP Stocking Standards (**Appendix 8**).
- Increase pine planting densities to 2200-2500 stems per hectare in pine leading plantations (at least 50% pine);

- Plant non-host species such as Hybrid spruce, Subalpine fir, Western Larch and Interior Douglas-fir, where these species are ecologically acceptable;
- Conduct silviculture surveys during the period of rust sporulation (May thru July);
- Accurately report forest health information in RESULTS.

Prior to stand density treatments, such as spacing, always conduct rust assessments in plantations where the pine component is greater than 80%. Studies have shown that even stands free of rust at the time of treatment can develop infection.

Currently, the most effective management tactic for pine stem rusts is to reforest with non-host species. Non-host species also provide increased diversity and stand resiliency. However, this tactic is not always possible due to sites with dry conditions. In areas that are too dry to plant non-susceptible species such as spruce or balsam, **greater initial densities of pine should be established**. Experience with pine plantations that have failed in susceptible rust areas suggests that initial densities of 2200-2500 stems/hectare are required for a stand to achieve free growing and remain productive into the future.

## Warren's Root Collar Weevil (*Hylobius warreni*)

***Medium priority***

### *Ranking Rationale*

This insect is considered a medium priority forest health issue in plantations of pine and spruce, especially in areas where adjacent mature stands of pine have been dead for 4-5 years. While the losses resulting from Warren root collar weevil have historically been considered minor, recent experience indicates there was increased weevil activity where plantations abutted with dead mature Pl stands killed by MPB

Limited monitoring of damage caused by root collar weevil occurred for several years after the peak of the MPB epidemic (which occurred in 2005 and 2007, in the Lakes and Morice TSA's, respectively). This included a research project (http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2664.2010.01797.x/full) that clearly showed more damage was occurring in these adjacent plantations, particularly along the plantation edges. This activity seems to have been short lived, and weevil populations have likely returned to pre-MPB epidemic levels, as it has been ten years since the peak of the infestation. This research also suggests that further monitoring should be conducted, so FLNRO staff will continue to conduct this monitoring through flights and ground surveys.

### *Management Tactic*

In high hazard areas, especially in the SBSmc subzone, where adjacent standing MPB-killed trees have been dead for 5 years, consider the following tactics:

- Include a general assessment of root collar weevils within the area to be harvested and the adjacent mature pine stands for an indication of weevil populations;

- Delay planting by 2-3 years. Seedlings will not be attacked until they have a root collar of at least 2 cm;
- Plant a less susceptible tree species along cutblock edges. Host species are mainly lodgepole pine, but also Engelmann, white, and hybrid spruce;
- Reduce duff layers. This includes treatments such as broadcast burning, scarification mounding and disc-trenching;
- Increase planting density. Recommend higher than 1600 stems per hectare in anticipation of mortality;
- Delay spacing until stand is at least 20 years old;
- Produce hazard and risk maps.

## Foliar Diseases of Conifers

***Low to medium priority***

### *Management Objective*

To mitigate the effects of foliar disease on stand productivity.

**Foliar diseases of increasing concern in the Nadina district:**

*Dothistroma septosporum* - Dothistroma

*Phaeoseptoria contortae*

*Lophodermella concolor* - Pine needle cast

*Hendersonia pinicola*

*Rhizosphaera kalkhoffii* - Rhizosphaera needle blight

*Pucciniastrum epilobii* - Fir-fireweed rust

*Leptomelanconium*

### *Ranking Rationale*

Foliar diseases are considered to be a low to medium priority forest health factor in the Nadina District. However, the example of Dothistroma needle blight (*Dothistroma septosporum*) of lodgepole pine in the Northwest should be seen as a warning of the potential risk that foliar diseases may pose. This risk may well intensify given current predictions of climate change.

In 2008, aerial surveying of 78 randomly selected openings in the Morice TSA indicated that 35% of these blocks had some level of Dothistroma. Of the 78 blocks, 33% had some level of *Lophodermella* either alongside *Dothistroma* or on its own. In 2011, these blocks were re-

visited and the results indicate that the Dothistroma had declined. Although 44% of the blocks had the foliar disease present, it was found only in trace amounts (<1%) with the exception of 1 block which remains approximately 30% affected.

The summer of 2011 was particularly wet and as a result, the Dothistroma spores flourished and the damage was evident in 2012. Forty-five blocks were re-assessed, plus 5 new plantations and the results showed that 52% blocks had some level of Dothistroma present. Continued monitoring is planned for 2016.

See **Figure 2.3.4** for general locations.

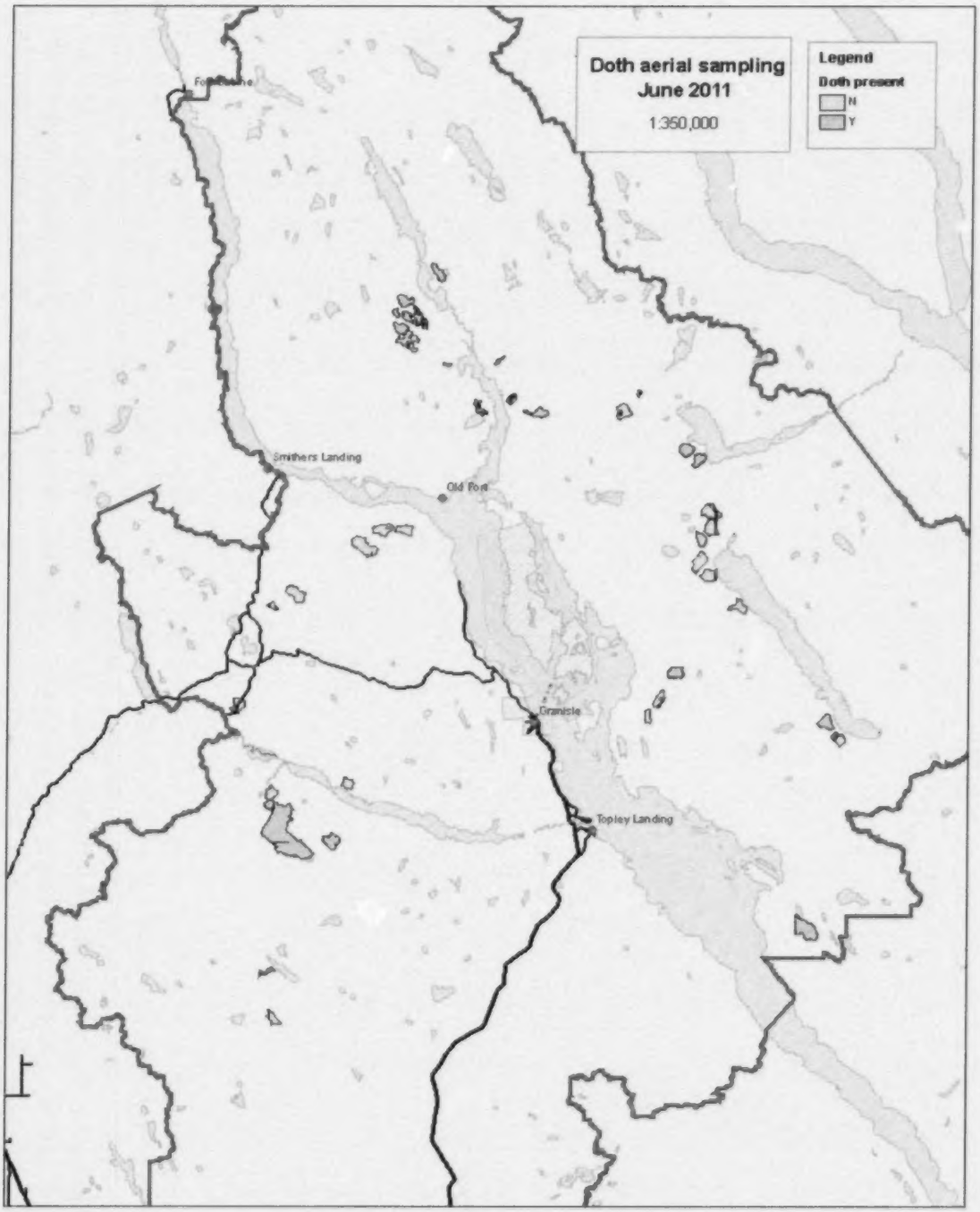
Refer to **Appendix 3** for a pamphlet on characteristics for field identification of common foliar diseases in the Nadina district. Refer to **Appendix 4** for the method of determining the level of foliar damage on conifers.

*Management Tactic*

For Dothistroma:

- Incidence levels should continue to be monitored, especially in high-hazard areas which are SBSmc subzones.
- Encourage species diversity in plantation establishment. Recommend planting a maximum of 20% pine in high-hazard areas.
- Avoid planting pine in cold-air ponding sites.
- Avoid planting pine in wetter ecosystems. Areas of higher relative humidity, like along bogs/ swamps, watercourses and brushy sites, are prone to Dothistroma disease.
- Monitor annual precipitation. For Dothistroma, there is a correlation between infection levels and warm, summer rain and relative humidity.
- There are no management tactics for the other foliar diseases at this time.

**Figure 2.3.4 Dothistroma Location Map**



## Insect Defoliators

There are only a few serious insect defoliators in the Nadina District on mature trees: 2-year cycle budworm (*Choristoneura biennis*) on conifers, and Large aspen tortix (*Choristoneura conflictana*) and Aspen serpentine leaf miner (*Phyllocristis populiella*) on deciduous trees. There have been localized areas of damage by black army cutworm (*Actebia fennica*) associated with large wildfires in the district in the last 5 years.. From an operational stand-point, 2- year cycle budworm is the main pest of concern.

### *2-year Cycle Budworm (Choristoneura biennis)*

***Low priority***

#### *Management objective*

Reduce height and volume losses in mature trees, and damage to new plantations.

#### *Ranking Rationale*

The 2-year cycle budworm is considered a medium priority in the Morice TSA and a low priority in the Lakes TSA. There was approximately 100,000 ha increase in incidence between 2007 and 2009. Generally, the budworm does not cause wide-spread mortality, but rather height and volume loss; however, tree mortality can occur after several successive years of severe defoliation, particularly on immature or suppressed trees. This insect also tends to have cyclical population dynamics that can rise to high levels in some years and then fall abruptly. The provincial aerial overview survey showed a very low incidence between 2012 and 2014 with an increase to approximately 8000 ha in 2015. Monitoring will be conducted in 2016.

#### *Management Tactic*

- Prioritize damaged timber for harvest;
- Consider reforesting with non-host species, especially along cutblock edges;
- Improve tree vigour with fertilization;
- Reduce stand densities with thinning;
- Continue ground and aerial monitoring of spread and impact;
- Other management tactics are outlined in the Defoliator Management guidebook
  http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/defoliat/defoltoc.htm

### *Black Army Cutworm (Actebia fennica)*

***Low priority***

### *Management objective*

Reduce damage to new plantations.

### *Ranking Rationale*

In 2012 there was a resurgence of damage by Black army cutworm (*Actebia fennica*). This defoliator of new plantations had not been seen, to any extent, in the Nadina District for 20 years. Several recent large wildfires seemed to bring the populations up to a level where they caused defoliation in several new plantations. While this insect tends to attack plantations in a fairly random manner, there are some things that can be done to reduce the likelihood of serious damage. A pilot trapping project occurred in 2013 to monitor Black army cutworm population levels, very low levels were found. Another trapping project may be undertaken in 2016 by district and regional staff to assess population levels in the China Nose area.

### *Management Tactic*

- Educate clients (MFLNRO staff, planters and other contractors) about the signs to look for to identify damage
- Ensure planting is timed to reduce damage from defoliator by delaying planting for 1 growing season in areas that have been burned.
- Monitor population levels after any major fires or slash burning events to allow better planting decisions to be made

## *Spruce weevil (Pissodes strobi)*

***Low priority***

### *Management Objective*

Reduce growth and yield losses due to weevil infestation in young plantations.

### *Ranking Rationale*

Spruce weevil is a low priority in the Nadina District. This weevil is only a concern in plantations with a high spruce component in the SBS and ESSF BEC zones. Stand level climatic factors and topography are the main factors in weevil development and spread. Though it doesn't cause tree mortality, the forking, heavy branching and deformities resulting from repeated attacks can cause substantial losses in lumber recovery. Climate change could increase severity.

### *Management Tactic*

- Plant a mix of conifer species;
- Plant a minimum of 1600 stems per hectare in areas with high spruce component.

- Consider leaving mature deciduous trees on site to act as shade trees. The coolness from the shade may reduce weevil survival.
- Delay spacing until trees are 7 m tall;
- Assess adjacent spruce stands for incidence levels, monitor and reassess annually;

## Pine Terminal Weevil (*Pissodes terminalis*)

***Low priority***

### *Ranking Rationale*

This insect is considered a low priority forest health factor in pine plantations.

### *Management Tactic*

Incidence levels should continue to be monitored and their priority reassessed at the annual review stage.

## Engraver Beetles (*Ips spp.*)

***Low priority***

### *Management Objective*

Avoid population build-up.

### *Ranking Rationale*

This insect is considered a low priority forest health issue in young pine plantations. Engraver beetle populations increase significantly following MPB epidemics, which could have implications for young pine stands in the Nadina district. Recent experience in the Vanderhoof District indicates that there is an increased risk of significant loss in plantations that are adjacent to MPB-killed stands. Flights conducted in the Nadina District show elevated risk of *Ips* infestation in free growing-aged stands adjacent to recent burns, and/or stands that have recently experienced light to moderate ground fires.

### *Management Tactic*

- Due to the increased risk associated with this beetle, more intensive surveys will be required in areas heavily attacked by MPB;
- Conduct assessment flights or more intensive surveys near recent wildfire areas;
- Spacing in plantations adjacent to MPB-killed stands should be avoided;
- Dispose of slash in a timely manner;
- Conduct pest identification and awareness programs.

- Report new infestations to Nadina staff.

## Lodgepole Pine Dwarf Mistletoe (*Arceuthobium americanum*)

***Low priority***

### *Ranking Rationale*

Lodgepole pine dwarf mistletoe is a low priority forest health factor in the Nadina district. Prior to MPB, mistletoe existed in a patchy distribution. Currently, with the majority of mature host trees dead, mistletoe incidence should be on the decline, however it can still be found on immature and understory pine that have survived the MPB epidemic so this disease must still be managed for.

### *Management Tactic*

- Monitor susceptible stands and closely examine advanced pine regen to be retained during harvest.
- Where mistletoe is found, follow the tactics outlined in the Dwarf Mistletoe Management Guidebook:

http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/dwarf/dwarftoc.htm

## Root Diseases

***Low priority***

Tomentosus – *Inonotus tomentosus*

Schweinitzii butt rot – *Phaeolus schweinitzii*

### *Management objective*

Reduce the impact to forest productivity and biodiversity.

### *Ranking Rationale*

Tomentosus root disease is a low priority forest health factor in the Nadina District. By nature, the pathogen is wide spread, but especially prevalent in spruce forests in the SBS BEC zones. Although the BC Ministry of Forests, Lands and Natural Resource Operations inventory appears to account for the mature volume loss in its yield model VDYP, this volume loss estimate illustrates the potential for increased stand productivity if tomentosus root disease is proactively managed. The impact of Tomentosus root disease on the productivity of second growth stands is being investigated by the Regional forest pathologist. Increased use of spruce in regenerating stands increases the importance of Tomentosus detection.

### *Management Tactic*

For Tomentosus:

- Assess levels of incidence pre-harvest;
- Plant with less susceptible tree species; the most susceptible tree species is Hybrid spruce, followed by Lodgepole pine;
- Practice avoidance planting; use a 5 meter buffer around infected stumps if a host species must be planted;
- For an intensive treatment, conduct a stumping program and reforest with ecologically suited tree species;
- Currently, there are no management tactics for Schweinitzii butt rot;
- For more information, consult the Root Disease Management guidebook. (http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/root/roottoc.htm)

## Rhizina Root Disease (*Rhizina undulata*)

***Low priority***

### *Ranking Rationale*

The risk of plantation failures due to Rhizina root disease has all but disappeared due to a decrease in the use of broadcast burning for site preparation. Consequently, Rhizina is considered a low priority forest health factor. This disease could be more of a problem for reforestation efforts after recent forest fires in the district.

### *Management Tactic*

- Avoid broadcast burning in areas with a history of Rhizina root disease. Incidence levels should continue to be monitored and their priority reassessed at the annual review stage.

## *Heart Rots*

***Low priority***

Brown crumbly rot - *Fomitopsis pinicola*

Red ring rot – *Phellinus pini*

### *Ranking Rationale*

Heart rots are a low priority forest health factor in the Nadina District. Mature and over-mature stands of spruce affected by these rot are often mistaken for stands infected by tomentosus root disease. There is no known relationship between mature stand infections and subsequent risk to plantations. Heart rots are subject to windthrow events.

*Management Tactic*

- Incidence levels should continue to be monitored and their priority reassessed at the annual review stage.

## *Drought*

***Low priority***

*Management Objective*

Minimize the losses due to drought.

*Ranking Rationale*

Currently, drought is a low management priority in the Nadina district. The potential for catastrophic drought events is increasing annually because of climate change. The Nadina district experienced warmer and dryer than usual conditions in 2013 & 2014 and although the district returned to more typical weather in 2015, most of the rest of the province experienced a drought. Drought killed seedlings were noted in plantations surveyed in 2014. Drought and climate change have also contributed to outbreaks of Aspen Leaf Miner and stem canker diseases on trembling aspen in the district. Aspen and Birch decline has also been linked to Climate Change/prolonged drought in western North America.

*Management Tactic*

- Assess stands for drought prior to planting and manage appropriately;
- Continue to observe, record and report incidents of drought killed seedlings;
- Plant species which are adapted to climate change and drought (such as Fdi & Lw) where appropriate.

## *Windthrow*

***Low priority***

*Management Objective*

Minimize the losses due to windthrow.

*Ranking Rationale*

Currently, windthrow is a low management priority in the Nadina district. The potential for catastrophic windthrow events is increasing annually because of contributing factors such as climate change and decreasing health of the forests. Unhealthy forests, such as those killed by mountain pine beetle, infected with root disease, or stem cankers are at highest risk for

becoming a causality of a wind event. Predicting large-scale wind events involves a complex relationship of climatic and biophysical factors that leaves a wide gap of uncertainty.

*Management Tactic*

- Assess stands for levels of root disease prior to harvest and manage appropriately;
- Assess road right-of-ways for structurally weakened trees that pose a safety hazard;
- Continue to observe, record and report incidents of windthrow;
- Remove fresh windthrow from the sites as soon as possible to avoid a build-up of insects such as Spruce bark beetle, Ips, and other insects of concern;
- Remove large quantities of MPB-killed windthrow from the site to reduce the fire hazard.

## Mammal Damage

***Low priority***

*Management Objective*

To reduce seedling mortality and damage caused by small mammals such as vole and hare.

*Ranking Rationale*

Currently, mammal damage is considered a low priority forest health factor in the Nadina District. Vole and hare populations in plantations, and the potential damage their feeding can cause, are cyclical. Hare populations peaked in 2013-2015 and evidence suggests that there are still, at least patches, of high hare populations on the landscape. There is some concern that we may see prolonged peaks in populations due to influences such as climate change, increased habitat due to changes in seral stage distribution brought on by the mountain pine beetle epidemic and large scale fires in the district, and the crash of Northern Goshawk and other raptor populations. **(see Doyle, F, I. 2015: Occupancy and Status of Northern Goshawk Breeding Areas in the Coast Mountain (Kalum), Nadina and Skeena Stikine Resource Districts 2015. MFLNRO and CANFOR.)**

*Management tactic*

- Population levels will continue to be monitored in harvested landscapes and their priority reassessed annually
- Limit premium hare habitat that provide foraging opportunities and protection from predation.
- Refer to research report "Snowshoe hare Population trend within Harvested Landscapes in Central-Northwest British Columbia" for planting guidelines.

## Snow Damage

***Low priority***

### *Management Objective*

To reduce seedling mortality and volume loss in regenerated stands caused by heavy snow loads.

### *Ranking Rationale*

Currently, snow press is considered a low priority forest health factor in the Nadina district. SDM results show that 67% of blocks sampled had some level of unacceptable snow press damage. Damage levels were generally low with only 4% of blocks sampled having greater than 10% damage. Evidence of the large snow event that happened in 2006 is still visible in sampled stands. An increase in heavy snow events can be anticipated in conjunction with climate change.

### *Management tactic*

- Monitor and assess damage in regenerating stands, especially after major snow events.
- Consider density management activities on stands that are at or near maximum density.
- Identify areas that historically have higher snow packs. Regenerate stands in these areas with species that have crowns less prone to snow damage, like Spruce and Balsam. Avoid planting big stock ("super trees") and higher densities on these sites.

## Pine Tip Dieback – Cenangium Canker (Cenangium ferruginosum)

***Low priority***

### *Management Objective*

Monitor and report occurrences in the district.

### *Ranking Rationale*

In 2011 district staff noticed a tip/leader dieback affecting pine plantations in the Nadina district. An overview flight recorded over 60 waypoints, and samples were collected from several sites throughout the southeast portion of the district. Permanent sample plots were also established. The severity seems to have declined since with no evidence of mortality, however, it was noted in one SDM block in the Bird Lake area in 2015.

### *Management tactic*

- Monitor and report occurrences in the district.
- Regional and district staff will continue to monitor PSP's

# 3.0 BARK BEETLE COMPONENT

## 3.1 Background

The *Provincial Bark Beetle Management Technical Implementation Guidelines* are used to inform bark beetle investment decisions (http://www.for.gov.bc.ca/hfp/health/fhdata/ProvBBStrategy.pdf).
These guidelines are designed to focus limited resources where direct management can have the greatest impact on beetle populations within areas identified as priorities to protect the current and mid-term timber supply.

*Objectives*

**1.** Focus bark beetle management investments in areas that maximize benefits.

**2.** Implement policies that encourage industry participation in efficient and effective beetle management.

## 3.2 Tactical Options

Selected tactics will balance the risk from beetle infestations and the need to maintain other resource values. To facilitate this balance, particularly where there are other resource values, tactical matrices for mountain pine beetle and spruce beetle have been developed. These matrices identify the range of tactical options available to address beetle suppression.

Sample standards for detection and treatment of bark beetle can be found in **Appendix 5.**

## 3.3 Spruce Beetle *(Dendroctonus rufipennis)*

***Very High priority***

*Ranking Rationale*

Spruce beetle is considered a **very high** priority forest health factor. The recent mountain pine beetle epidemic has placed a much greater reliance on spruce to mitigate timber supply impacts in the mid-term. Although there are no large outbreaks currently in the Nadina, there are reports of infestations in neighboring districts and the provincial aerial overview survey has shown an increase in the last two years. District and regional staff will be conducting aerial monitoring and ground surveys this year. Tenure holders are urged to report substantial IBS infestations to Nadina staff upon their detection.

*Management Tactic*

Management of spruce beetle should conform to those tactics outlined in *Bark Beetle Management Guidebook*. Spruce blowdown should be reported and managed/actioned quickly.

*Table 3.3.1 – List of SBB BMUs, their management strategies, and corresponding harvest priorities.*

| BMU Strategy | Performance targets * | Management Strategy | Harvest Priority | Harvest Postponed for Future Use |
|---|---|---|---|---|
| **Suppression /Preventiont** **(Entire Nadina District)** | 80% of current infestations | Monitor and action new infestations through fall & burn, trap trees or small patch cuts. Operations within Suppression/Prevention BMUs need to be consistent with the Lakes and Morice LRMPs and *Guidance on Landscape and Stand Level Structural Retention in Large-Scale MPB Salvage Operations – December 2005.* | As per Hazard & Risk Rating below | N/A |

**refers to number of sites treated before the next flight.*

*Hazard rating – Spruce*

| *Hazard Class* | *Criteria* |
|---|---|
| Extreme | - Spruce Leading Species (>50%)<br>- Age Class 7, 8 or 9<br>- Site Index >= 15 |
| High | - Spruce Leading Species<br>- Age Class 7, 8 or 9<br>- Site Index < 15 |
| Moderate | - Spruce Secondary Species (21 – 49%)<br>- Age Class 7, 8 or 9<br>- Site Index - all |
| Low | - Spruce Leading<br>- Age Class 5 or 6<br>- Site Index - all |

*Risk Rating – Spruce*

| *Risk Rating* | *Description* |
|---|---|
| Very High | Infestations within 2 km of a high or extreme hazard stand (>5 yellowing/red topped spruce). |
| High | Infestations within 2 km of a moderate hazard stand (>5 yellowing/ red topped spruce). |
| Moderate | Infestation between 2 and 10 kilometres of a high or extreme hazard stand (>5 yellowing/red topped spruce). |

| | |
|---|---|
| Low | Infestations within 2 km of a low hazard stand (>5 yellowing/red topped spruce). |
| Very Low | Infestations more than 10 km from a high or extreme hazard stand (>5 yellowing/red topped spruce). |

*The spruce beetle tactical matrix is based on the following tactics:*

- Tactic 1: fall and burn
- Tactic 2: conventional trap trees
- Tactic 3: single tree harvesting of infested trees
- Tactic 4: small patch sanitation (< 1.0 hectare patches)
- Tactic 5: small clearcut (between 1.0 and 5.0 hectares or greater than 500m$^3$ and less than 2000m$^3$).
- Tactic 6: standard harvest practices (clearcut and clearcut with reserves)
- Tactic 7: no treatment

*Table 3.3.2 Spruce Beetle Tactical Matrix*

| **Constrained Areas** | | | | | |
|---|---|---|---|---|---|
| ***Area Type*** | ***Risk Rating and Treatment Tactics*** | | | | |
| | ***Very Low*** | ***Low*** | ***Mod*** | ***High*** | ***Very High*** |
| **Deferred Areas Within Prescriptions** | 1,3,7 | 1,3,7 | 1-6 | 1-6 | 1-6 |
| • Applies to leave areas **available** for harvest later in the rotation where adjacent harvested areas have not met green-up.<br>• Where patch size limits can be met, tactic 5 is available, otherwise use tactics 1-4 and retain 40% basal area, on a deferred area basis | | | | | |
| SMZ/Connectivity Corridors | 1,3,7 | 1,3-6 | 1,3-6 | 3-6 | 3-6 |
| • restrictions as per LRMP or Land Use Objective | | | | | |
| Ungulate Winter Habitat | 1-7 | 1-6 | 2-6 | 2-6 | 2-6 |
| • As per Notice – *Indicators of the Amount, Distribution and Attributes of Wildlife Habitat Required For the Winter Survival of Ungulate Species in the Lakes (Morice) Timber Supply Area(s)*<br>• As per Morice Mountain Goat GAR (U 6-003) & the Telkwa Caribou GAR (WHA 6-333) | | | | | |
| **Visual** | | | | | |
| • All tactics available as long as Visual Quality Objective is met. | | | | | |
| **Riparian Features in Previously Harvested Blocks** | | | | | |

| *Area Type* | *Risk Rating and Treatment Tactics* | | | | |
|---|---|---|---|---|---|
| | *Very low* | *Low* | *Mod* | *High* | *Very High* |
| **Riparian Reserve Zones – streams, lakes, wetlands** | 7 | 7 | 7 | 7 | 1,3,7 |
| • Maintain the integrity of the reserves. Meet the riparian objectives of the FSP.<br>• Do not use conventional trap trees or pheromone baits within the riparian reserve. | | | | | |
| **Riparian Management Zones – streams, lakes, wetlands** | 7 | 7 | 1,3,7 | 1,3,7 | 1,3,7 |
| • Meet riparian management zone objectives of the FSP. | | | | | |

| **Riparian Features in Blocks yet to be Harvested** | | | | | |
|---|---|---|---|---|---|
| *Area Type* | *Risk Rating and Treatment Tactics* | | | | |
| | *Very Low* | *Low* | *Mod* | *High* | *Very High* |
| **Riparian Reserve Zones – streams, lakes, wetlands** | 7 | 7 | 7 | 7 | 1,3 |
| • Target removal of current attack and Y1s.<br>• The removal of incidental trees to facilitate this target should be kept to a minimum.<br>• Do not use conventional trap trees or pheromone baits within reserve zone. | | | | | |
| **Riparian Management Zones – streams, lakes, wetlands** | 7 | 1,7 | 1,3-6 | 1,3-6 | 1,3-6 |
| • Do not use conventional trap trees or pheromone baits within the management zone.<br>• Target beetles while maintaining the riparian objective of the FSP. | | | | | |
| **Wildlife Tree Patch** (Outside of riparian reserve) | 7 | 7 | 1,3-7 | 1,3-7 | 1-7 |
| • Depending on the size of the infestation, a number of options are available ranging from single-tree treatment to full removal of the patch with substitution.<br>• If the WTP is not tied to a resource feature, then look for replacement location first, providing it meets stand level biodiversity targets in the FSP. May require a re-appraisal if CP has been issued. | | | | | |
| **Wildlife Trees** | 7 | 7 | 7 | 7 | 7 |
| | | | | | |
| **Coarse Woody Debris** | — | — | — | — | — |
| • Do not use green spruce to meet CWD objectives. | | | | | |

## 3.4 Mountain Pine Beetle (*Dendroctonus ponderosae*)

***High priority***

### *Ranking Rationale*

Mountain pine beetle is considered a **high** priority forest health factor in both the Lakes and Morice TSAs. Approximately 51% of the stands in the Morice Timber Harvesting Landbase (THLB) are dominated by pine, and 76% of the stands in the Lakes THLB are dominated by pine. The majority of these stands are greater than 60 years of age. The peak of the recent infestation occurred in 2005 in the Lakes TSA and in 2007 in the Morice TSA. The majority of the district was heavily attacked by the pine beetle, however mortality in the Morice TSA stabilized at 56 % and the Fulton, Granisle and Morrison Landscape Units, have significant levels of green pine remaining.

### *Management Tactics*

As endemic beetle populations have returned throughout the District, it is apparent that we must expand our tactics to fully reflect stewardship and social considerations. Planning and harvesting of stands affected by MPB requires resource managers to maintain other resource values, as well as protect non-affected trees for mid-term timber supply.

Management objectives concerning MPB include:

- Continue annual monitoring of beetle rate of spread;
- Reduce negative impacts of bark beetle infestations and salvage operations on biodiversity and other forest values;
- Direct harvest into pine-leading stands where the absolute mortality is >70%;
- Retain attacked stands that have a secondary structure component that makes them viable in the mid-term;
- Ensure immediate reforestation of attacked areas.

These objectives are consistent with the Provincial Mountain Pine Beetle Action Plan and the goals and management direction of the Morice and Lakes LRMPs.

Management of mountain pine beetle should conform to those tactics outlined in the *Provincial Bark Beetle Management Technical Implementation Guidelines* and the *Bark Beetle Management Guidebook*. In addition, the harvest priorities outlined in **Table 3.3.1** should be considered when planning and harvesting MPB-attacked stands which will aid towards achievement of the management objectives listed above.

*Table 3.4.1 – List of MPB BMUs, their management strategies, and corresponding harvest priorities.*

| BMU Strategy | Performance targets * | Management Strategy | Harvest Priority | Harvest Postponed for Future Use |
|---|---|---|---|---|
| **Suppression /Prevention (Fulton, Granisle, Morrison)** | New Infestations: 80% within 1 year 100% within 2 years | Monitor and action new infestations through Fall & Burn or small patch cuts. Continue to salvage beetle killed stands within these landscape units. Operations within Suppression/Prevention BMUs need to be consistent with the Lakes and Morice LRMPs and *Guidance on Landscape and Stand Level Structural Retention in Large-Scale MPB Salvage Operations – December 2005.* | Current attack & Previously attacked stands with: > 70% Pl > 50% dead ≥ Age Class 4 | •Sx/Bl leading stands & Pl leading stands < Age Class 4 < 50% dead |
| **Salvage (all of the Lakes TSA & most of the Morice TSA)** | | Minimize unsalvaged losses by harvesting beetle-killed trees. Salvage operations need to be consistent with the Lakes and Morice LRMPs and *Guidance on Landscape and Stand Level – Structural Retention in Large Scale Mountain Pine Beetle Salvage Operations – Dec., 2005.* | Attacked, pine-leading stands in Lakes/Morice: > 70% Pli > 50% dead ≥ Age Class 4 | •Stands ≥ 5 hectares with secondary structure meeting the following criteria **Lakes TSA only**: Min. 700 ws/ha ≥6 metres ht Min. 900 ws/ha ≥ 4 metres ht |
| | | | | •Sx/Bl leading stands & Pl leading stands < Age Class 4 < 50% dead |

**refers to number of sites treated before the next flight. The priority of the Salvage strategy is to salvage timber previously attacked to minimise value loss.*

The MPB tactical matrices are based on the following tactics:

- Tactic 1: single tree harvesting of infested trees.
- Tactic 2: small patch sanitation (< 1.0 hectare patches)
- Tactic 3: small clear-cut (between 1.0 and 5.0 hectares **or** less than 2000m$^3$ **or** a non-clear-cut system)
- Tactic 4: standard harvest practices (clear-cut and clear-cut with reserves)
- Tactic 5: no treatment; leave as is

*Table 3.4.2 Mountain Pine Beetle Tactical Matrices*

| Leave Types | |
|---|---|
| **Deferred Areas Within Prescriptions** | |
| • Applies to leave areas **available** for harvest later in the rotation where adjacent harvested areas have not met green-up.<br>• Where patch size limits can be met, use tactic 4, otherwise use tactics 1-3 and retain 40% basal area. | |
| **SMZ/Connectivity Corridors** | |
| • Tactics 1-5 are available, depending on legal objective. | |
| **Ungulate Winter Habitat** | |
| • As per Notice – *Indicators of the Amount, Distribution and Attributes of Wildlife Habitat Required For the Winter Survival of Ungulate Species in the Lakes (Morice) Timber Supply Area.*<br>• Must comply with the Morice Mountain Goat GAR (U 6-003), the Morice Bull Trout GAR's (U 6-283, U 6-284, U 6-285 & U 6-286) & the Telkwa Caribou GAR (WHA 6-333)<br>• Tactics 1-5 are available depending on wildlife requirements. | |
| **Visual** | |
| • All tactics available as long as Visual Quality Objectives are met. | |
| **Blocks previously harvested** | **Blocks yet to be harvested** |
| **RRZ - Riparian Reserve Zones (streams, lakes, wetlands)** | **RRZ -Riparian Reserve Zones (streams, lakes, wetlands)** |
| • Use tactic 5 – no treatment | • Use Tactic 5 – leave as is. |
| **RMZ -Riparian Management Zones** | **RMZ -Riparian Management Zones -** |
| • Use tactic 5 – no treatment | • Tactic 1-5 available as long as site plan is followed |
| **WTP - Wildlife Tree Patch (outside of riparian reserve)** | **WTP - Wildlife Tree Patch (outside of riparian reserve)** |
| • Use tactic 5 – no treatment | • Prefer tactic 5.<br>If the WTP is not tied to a resource feature, then look for replacement location first, providing it is required to meet stand level biodiversity targets. May require a re-appraisal if CP has been issued. |
| **Wildlife Trees** | **Wildlife Trees** |
| • Use tactic 5 – no treatment | • Use Tactic 5. |
| **Blocks in Salvage designation** | **Blocks in Holding designation** |
| • Tactic 4- standard harvest practices | • Tactics 3 and 4<br>• May be combined with pheromone baiting |

*MSMA (monosodium methane arsenate)*

The use of MSMA in the Nadina District ceased in 2004. If legacy trees are encountered in operations, refer to the legacy tree management brochure in **Appendix 6**.

## 3.5 Western Balsam Bark Beetle (*Dryocoetes confusus*)

***Low to medium priority***

### *Ranking Rationale*

Western balsam bark beetle is considered a medium priority forest health factor in the Morice TSA, and a low priority forest health factor in the Lakes TSA. The western balsam bark beetle has caused widespread damage throughout the Morice TSA. Generally, the same stands are attacked year after year resulting in chronic low levels of mortality. Although there appears to be an increased trend in mortality associated with the balsam bark beetle, more research is required to understand whether that trend is significant. The Mountain pine beetle epidemic has placed greater reliance on balsam to mitigate timber supply impacts in the mid-term.

### *Management Tactics*

The attack dynamics of balsam bark beetle do not easily lend themselves to direct control actions. Therefore, no tactical matrix has been developed for this beetle. Management will continue to be restricted to the harvest of infested trees as they occur within harvest settings resulting from typical development planning activities. Balsam bark beetle infested trees will not be explicitly targeted.

An initial study measuring the extent of losses due to western balsam bark beetle in the Morice TSA was completed by the MFLNRO's Regional Entomologist in 1999. While this study concluded that losses to IBB were included in VDYP calculations, other recent studies have suggested that damage in ESSF stands by western balsam bark beetle is continual (Maclauchlan, 2015). Further monitoring of high elevation balsam-leading stands in the Morice TSA is warranted in order to better quantify losses to this insect, particularly in light of potential climate change induced stress.

## 3.6 Douglas Fir Beetle (*Dendroctonus Pseudotsugae*)

**Low priority**

### *Ranking Rationale*

Douglas fir beetle is considered a low priority forest health factor in the Lakes TSA, and is not a factor in the Morice TSA. The host species occurs in a few scattered areas within the Lakes TSA and does not occur in the Morice TSA. The Douglas fir beetle has occurred historically within the Lakes TSA specifically along the north shore of Francois Lake at the end of the Jake Rd. The provincial aerial overview survey has identified some infestations south of Haney Lake and there have been some infestations reported/actioned to the east in the Vanderhoof district. This is a significant area for a local Douglas fir seed source.

### *Management Tactics*

Area identified by the provincial aerial overview survey will be ground truthed by district staff in the spring of 2016. This area is currently encompassed by existing or proposed OGMA's, so any

infestation will be contained by single tree treatments such as pheromone baiting and fall and burn.

## 4.0 INVASIVE PLANTS

*Background*

The introduction and spread of a variety of invasive alien plant species is adversely affecting ecological, economic, and social values. Among their many impacts, invasive alien plants threaten rare and endangered species, reduce habitat value, reduce land values and crop and forage yields, and decrease land and aquatic recreational use. They reproduce rapidly, are resilient and can overwhelm existing vegetation (both native and naturalized).

An example is hawkweed (*Hieracium spp*), which is a very aggressive invader that out-competes cultivated grasses and conifer seedlings. Hawkweed grows in clonal populations that displace a wide range of native vegetation and produces a hay fever response in most people, leading to health impacts and associated personal and social costs. It is estimated that by 2020 there will be an associated annual economic impact of $60 million provincially.

Invasive alien species are managed in the Nadina District through an inter-agency approach in collaboration with the Northwest Invasive Plant Council (NWIPC), as a sub-group of the Invasive Species Council of BC (ISCBC).

*Management Objective*

To limit or prevent the introduction or spread of invasive alien species in the Nadina District by soliciting and following the guidance from FLNR specialists with input from the NWIPC and the ISCBC.

*Management Tactic*

- Prevent the introduction or spread of invasive plants as per *FRPA Section 47 and FPPR Section 17* by adopting *Best Practices for Preventing the Spread of Invasive Plants during Forest Management Activities* (publication available through ISCBC) including:
    - Incorporating known invasive plant sites into development plans;
    - Reporting new sites as they are discovered;
    - Cleaning equipment before moving to a new work site;
    - Minimizing soil disturbance and maintaining native vegetation;
    - Re-vegetating disturbed sites as soon as possible
- Report invasive plant locations either directly through the Invasive Alien Plants Program (IAPP), or http://www.reportaweedbc.ca or through the NWIPC hotline 1-866-44WEEDS;

- Recognize and report the highest priority invasive plant species of concern in the Nadina District: Field Scabious, Spotted & Diffuse Knapweed, Marsh Plume Thistle, the knotweeds, Sulfur Cinquefoil and Common Tansy;
- Promote awareness and facilitate species identification programs.

# 5.0 OPERATIONAL ACTIVITIES 2016-2017

*Spruce Bark Beetle*

Monitoring flights will be conducted in the spring to check areas identified in the provincial aerial overview survey and to assess high risk spruce stands. Monitoring traps may be deployed to assess beetle populations. Reports of IBS activity by the public and tenure holders will be followed-up by District staff and an appropriate action plan developed. Limited funding is available for single-tree treatment in high-priority areas. Licensees are encouraged to carry out a trap tree program for mop-up and management purposes within their Cutting Permits and to report areas of fresh blowdown.

Current areas of concern are Southeast Ootsa and China Nose where spruce trees were damaged by the fires of 2014. Other areas of concern identified by the provincial aerial overview survey are the Morrison, Flemming Lake, the Chisholm, Ling Lake, Hanson/Helene, West Francois, Sather Lake, Bird Lake and the Deerhorn areas.

*Mountain Pine Beetle BMUs*

The District will conduct aerial reconnaissance of the Fulton, Granisle & Morrison landscape units to assess the amount of green pine stands remaining and the amount of current attack and to update the strategies.

*Dothistroma*

The District conducted an aerial reconnaissance of 78 randomly selected blocks on May 28, 2012, which were originally surveyed in May 2008. The objective was to monitor and record the presence and magnitude of the foliar disease in the Morice TSA. The results indicated that 47% of the blocks had some level of Dothistroma, which was an increase from the previous year. In addition, three new blocks in the flight area were observed having the foliar disease. There are concerns that Dothistroma may be on an upswing due to recent weather patterns, a flight will be conducted by regional and district staff in the spring of 2016 to re-evaluate.

*Stand Development Monitoring*

The District will continue to participate in Stand Development Monitoring (SDM), an objective

of the provincial FREP program. In SDM, the health of managed stands is assessed and recorded. The results of a SDM assessment can be used as an evidentiary base to support Forest Practices and Planning Regulation section 97(6) which states "a free growing stand must also meet the requirements, 20 years after the commencement date or 5 years after the completion of the last of any brushing or spacing treatments, and that it will more likely than not be free of forest health concerns or vegetative competition that could result in its growth being impeded."

*Secondary Beetle Monitoring*

Secondary beetles, such as twig beetle (*Pityogenes spp*) and *Ips spp* usually attack dead or dying trees. It has been observed that the incidence and severity of both beetles have increased in young pine stands, and in some cases, in healthy trees previously free of disease or pest. A monitoring program has been developed using cross vane panel traps and Lindgren funnel traps. There are 2 trap locations in the Lakes TSA and 2 trap locations in the Morice TSA. Additional trap locations will be added around the China Nose & Chelaslie fires.

*Forest Health Transects*

More forest health transects will be established in randomly selected young stands to continue to assess forest health concerns such as hard pine rusts and Warren's root collar weevil.

## 6.0 LIST OF RESOURCES

**Warren Root Collar Weevil Stand Establishment Decision Aid**
Authors: Larry McCulloch, Brian Aukema, Ken White, Matthew Lingenberg, 2009
http://forrex.org/sites/default/files/publications/jem_archive/ISS51/vol10_no2_art8.pdf

**Dothistroma Stand Establishment Decision Aid**
Authors: Larry McCulloch, Alex Woods 2008
http://www.forrex.org/publications/jem/ISS50/vol10_no1_art1.pdf

**Spruce Weevil and Western Spruce budworm Forest Health Stand Establishment Decision Aid**
Authors: Don Heppner and Jennifer Turner 2006
http://www.forrex.org/publications/jem/ISS38/vol7_no3_art6.pdf

**Forest Health Stand Establishment Decision Aid**
Authors: Art Stock, Marnie Duthie-Holt, Sheri Walsh, Jennifer Turner and Kathie Swift 2005
http://www.forrex.org/publications/jem/ISS27/vol6_no1_art6.pdf

**Provincial Bark Beetle Mangement Technical Implementation Guidelines 2003**
http://www.for.gov.bc.ca/hfp/health/fhdata/ProvBBStrategy.pdf

**Bark Beetle Management Guidebook**
http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/beetle/betletoc.htm

**MSMA risk analysis report**
http://www.for.gov.bc.ca/hfp/health/MSMA/BC%20MFR%20MSMA%20Final%20Report%20June%2015%202009.pdf

**Spruce Leader Weevil Hazard Rating for British Columbia, Draft V2**
Authors: Kirstin Campbell, Chris Hawkins, March 2008

**Snowshoe Hare Population trend within harvested Landscapes in Central-Northwest British Columbia**
Authors: Frank Doyle, Wildlife Dynamics Consulting, February 2010
https://www.for.gov.bc.ca/ftp/dnd/external/!publish/Forest_Health/Snowshoe%20Hare%20Pop%20Trend%20in%20Central%20BC.pdf

**Northwest Invasive Plant Council website**
http://www.nwipc.org

**MoFR Invasive Alien Plant Program (IAPP)**
http://www.for.gov.bc.ca/hra/Plants/index.htm

**Invasive Plant Council of BC– TIPS/best management practices**
http://www.invasiveplantcouncilbc.ca/resources/targeted-invasive-plant-solutions-tips

**Stand Development Monitoring protocol**
http://www.for.gov.bc.ca/ftp/HFP/external/!publish/FREP/Indicators/SDM%20Protocol%202011.pdf

Woods, Alex J. Albert Nussbaum, and Bill Golding. 2000. **Predicted impacts of hard pine stem rusts on lodgepole pine dominated stands in central British Columbia.** Canadian Journal of Forest Research. **30**: 476–481.
https://www.for.gov.bc.ca/hfd/library/FIA/2005/FSP_Y051207.pdf

Woods, A.J. 2004. Predicted impacts of hard pine stem rusts on lodgepole pine dominated stands in central British Columbia; Were our Assumptions Valid? FSP Project Number Y051207.
http://bvcentre.ca/files/research_reports/04-05ImpactsHardPineStemRusts.pdf

Woods, A.J. and Bergerud, W. 2008. **Are free-growing stands in the Lakes TSA meeting timber productivity expectations?** B.C. Ministry of Forests and Range, Forest Practices Branch, Victoria, B.C. FREP Ser. 013.FREP Report #13 http://www.for.gov.bc.ca/hfp/frep/publications/reports.htm#rep13 (accessed on 10 January, 2013)

Woods, Alex J. 2011. **Is the health of British Columbia's forests being influenced by climate change? If so, was this predictable?** Canadian Journal of Plant Pathology. **33(2)**: 117–126.

MacLauchlan, Lorraine 2015. **Quantification of Drycoetes confuses-caused mortality in subalpine fir forests of southern British Columbia.** Forest Ecology and Management 359 (2016) 210-220.

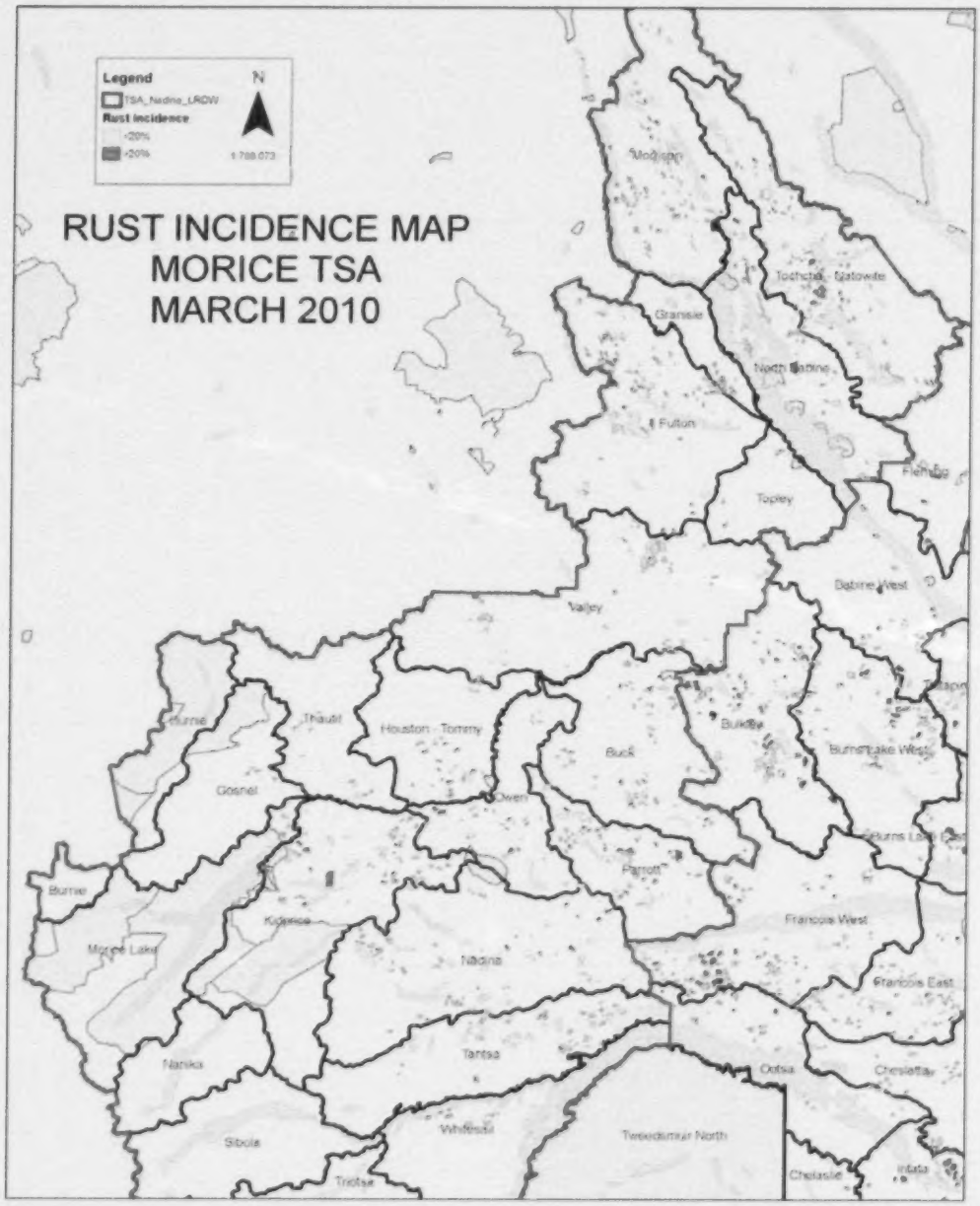
# 7.0 APPENDICES

## Appendix 1: Lakes TSA Rust Occurrence Map

**Rust incidence is ubiquitous: there appear to be a random pattern of distribution and incidence. Therefore, rust management is not limited to areas with higher risk of infection.**

## Appendix 2: Morice TSA Rust Occurrence Map

**Rust incidence is ubiquitous: there appear to be a random pattern of distribution and incidence. Therefore, rust management is not limited to areas with higher risk of infection.**



Characteristics for field identification of

## Common Foliar Diseases in the Lakes TSA

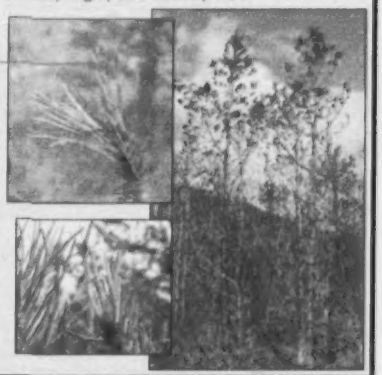
### Dothistroma Needle Blight (aka: Red Band Needle Blight)

(*Mycosphaerella pini, aka Dothistroma septospora*)

**Host Species:** All native and non-native pines (of any age) are susceptible

**What to look for:**

- Red bands on dead, brown needles
- Small black fruiting bodies are visible once the outer layer of the needle epidermis is ruptured
- Infections occurring in the lower crown, or in older needles (giving the visual effect of having been burned from the bottom up)
- Older infected needles are usually shed in the summer or over winter, leaving a "tufty" or "Lion's Tail" look to the remaining healthy branches
- Infected needles initially show yellow-brown spots or bands and eventually turn reddish-brown



Dothistroma needle photos: Dave Weaver, BC Ministry of Forests and Range

### Pine Needle Cast (aka: Lophodermella)

(*Lophodermella concolor, aka Hypodermella concolor*))

**Host Species:** Lodgepole Pine (usually young stands) is the primary host; restricted to "hard" pines.

**What to look for:**

- Needles infected in the previous year turn reddish-brown in the following spring and by summer turn straw coloured
- Fruiting bodies (small, oval depressions) are inconspicuous as they are the same colour as the infected needles
- Often found in association with *Hendersonia pinicola* (fruiting bodies appear as small, black dots on infected needles)
- Old infected needles are usually shed in the summer or over winter, leaving a "tufty" or "Lion's Tail" look to the remaining healthy branches

Lophodermella needle photo: Bob Erickson, Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre

**Characteristics for field identification of**

# Common Foliar Diseases in the Lakes TSA

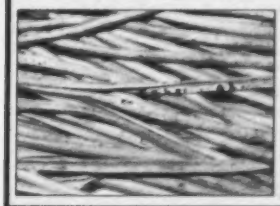
## Hendersonia (aka: Needle Cast Parasite)

(*Hendersonia pinicola*)

**Host Species:** Pine

**What to look for:**

- Central half of infected needles bleached white
- Black stains on the bleached white portion of the infected needles (stains left behind from spore tendrils)
- Often found in association with Lophodermella concolor (in already infected needles)



Hendersonia photos: Natural Resources Canada, Great Lakes Forestry Centre Photo Archive

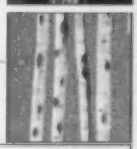
## Lophodermium Needle Cast

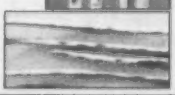
(*Lophodermium pinastri, and Lophodermium seditsiosum*)

**Host Species:** All 2 or 3 needle "hard" pine species ("soft", "white" or "5-needle Pines" seem resistant).

**What to look for:**

- Needles have pale spots in early summer, and turn yellow to brown, giving a mottled appearance, eventually turning completely brown
- Oval, grey or black fruiting bodies (resembling a plastic change purse) scattered over dead needles
- In late summer look for characteristic narrow, black bars (only in *L. pinastri*) on the dead sections of infected needles; bars maybe accompanied by minute black spots. *L. seditsiosum* does not have these lines





Lophodermium photo: Natural Resources Canada, Great Lakes Forestry Centre Photo Archive

Characteristics for field identification of

# Common Foliar Diseases in the Lakes TSA

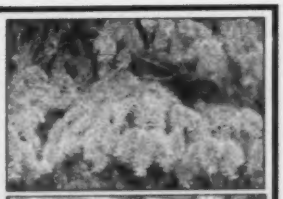
## Spruce Needle Cast (aka: Lirula Needle Cast)

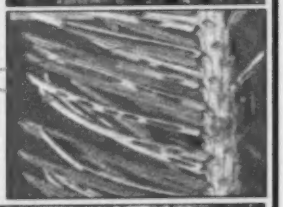
(*Lirula macrospora*)

**Host Species: White, Black, Sitka and Engelmann Spruce**

**What to look for:**

- The previous year's growth is affected (visible) due to a 2-year life cycle of the pathogen, current year's growth is usually not affected
- Fruiting bodies appear as elongate black lines, often running the full length of needles
- Dead needles are not shed and can stay on the tree for up to 2-3 years
- Needles start to turn brown in spring, eventually turning entirely brown, and then grey
- Infections are most common in the lower crown





Needle and Branch Photo: Natural Resources Canada, Great Lakes Forestry Centre Photo Archive. Twig photo: Paul E. Hennon, USDA Forest Service, United States

## Rhizosphaera (aka: Needle Blight)

(*Rhizosphaera kalkhoffii*)

**Host Species:** Spruce, (White Spruce, Engelmann Spruce and Colorado Blue Spruce are the most susceptible, Black Spruce, Sitka Spruce and Serbian Spruce are also affected, Norway Spruce seems to be resistant )

**What to look for:**

- Infections in current season's needles on lower branches (as spores are dispersed by dripping water)
- Infected and healthy branches appear together
- During late summer and early autumn, infected needles are yellow and mottled in appearance, eventually turning brown or purplish brown in colour

Rhisophaera photo: Natural Resources Canada, Great Lakes Forestry Centre Photo Archive

**Characteristics for field identification of**

# Common Foliar Diseases in the Lakes TSA

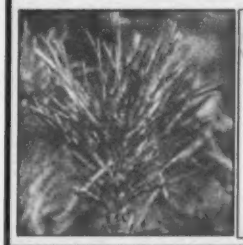
## Phaeoseptoria (aka: no common name)

*(Phaeoseptoria contortae)*

**Host Species:** Pine

**What to look for:**

- Red needles with black, transverse tiger stripes
- Current year's needles infected/attacked after full leaf-out



Phaeoseptoria photos: Alex Woods, BC Ministry of Forests and Range

## Elytroderma Needle Cast

*(Elytroderma deformans, aka Hypoderma deformans )*

**Host Species:** Lodgepole and Ponderosa Pines; restricted to "hard" pines

**What to look for:**

- Elongated, black fruiting bodies of various lengths (average 10mm) forming ridges and streaks on freshly killed red-brown needles
- Needles become straw-coloured when fruiting bodies are mature
- Groups of infected needles turn red and form conspicuous flags in the spring
- Infections can cause stunted growth or witch's brooms on infected branches

Elytroderma photo: Natural Resources Canada, Great Lakes Forestry Centre Photo Archive

**Characteristics for field identification of**

# Common Foliar Diseases in the Lakes TSA

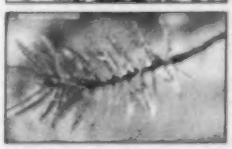
## Davisomycella (aka: Tar Spot Needle Cast)

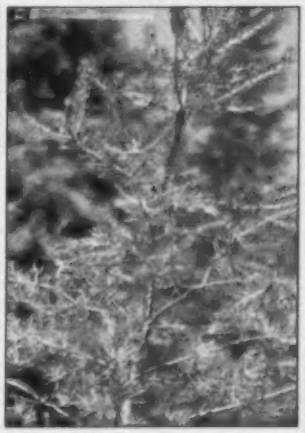
*(Davisomycella ampla, aka Hypodermella ampla )*

**Host Species:** Lodgepole Pine in BC, Shore Pine

**What to look for:**

- White, light, or straw-coloured infection areas are often separated from green tissue by an orange-brown band
- Oval, black fruiting bodies form on straw-coloured portions of needles.
- Fruiting bodies are relatively large, roughly the size/diameter of pencil lead.





Davisomycella photos: Natural Resources Canada, Great Lakes Forestry Centre Photo Archive

## Appendix 4 Foliar Damage Assessment Procedure

The following Free Growing Damage Standard applies to determinant growth conifer species including true firs, spruce, pines, and Douglas-fir. This standard does not apply to hemlocks and cedars that exhibit an indeterminant growth pattern. With determinant growth species it is possible to count internodes or years of growth. This standard is based on a comparison of the number of years of healthy needle retention, or healthy internodes, to an assumed healthy average of four years of needle retention. Determinant growth conifer species vary considerably in their ability to retain needles but for this standard, it is assumed that 4 years is the healthy benchmark.

The Free Growing Damage Standard for defoliation covers damage caused by both defoliating insects and foliar diseases. For all insect defoliators and all but one foliar disease, the damage threshold is 20%. Dothistroma* needle blight is the sole exception. Recent experience in northwest BC has shown that a 20% threshold for foliar retention is too low to define a **healthy** tree. The Free Growing Damage criteria for Dothistroma in the ICH, CWH and SBS is 50% foliar retention. Based on current observations of Dothistroma dynamics, a foliar retention threshold of 50% represents a more realistic threshold at which there is a reasonable likelihood that the stand will remain in a free growing condition.

The pattern of defoliation varies widely among different damaging agents. Some foliar diseases, for example, attack only the current year's growth while others attack other growth, but leave the current year intact. The three steps outlined below should guide surveyors to an appropriate call regardless of the pattern of damage.

The following steps should be followed to estimate the extent of healthy foliage. If a tree contains **more than 20%** of its foliage (more than 50% for Dothistroma) it is believed that the tree has a reasonable chance of recovery if the foliar disease or defoliating insect infestation were to subside, and so will be considered **Free Growing.**

**Step 1. Estimate the % Live Crown**

Visually draw a line perpendicular to the stem at the lowest point a green internode exists. A green internode is one in which > 50% of the needles in the internode are healthy. Estimate to the nearest 10% the extent of live crown. At age 10-15 healthy well-spaced conifer trees should normally have green needles close to the ground or 100% Live Crown.

**Step 2. Estimate the % of Healthy Internodes**

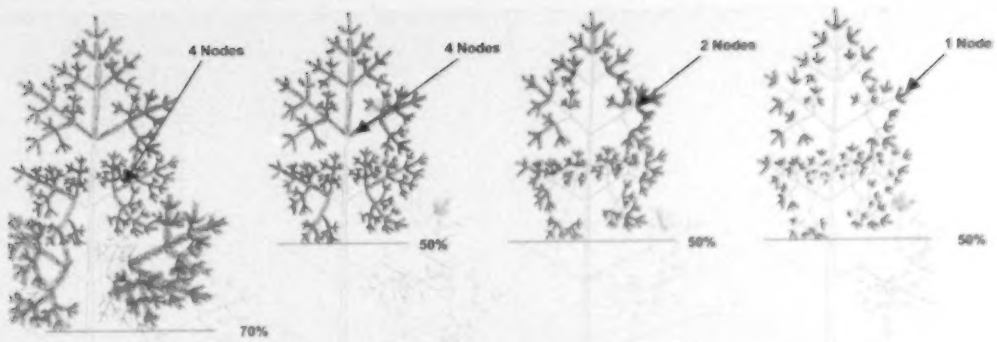
Normal healthy conifer species trees should have a full needle compliment on 4 elongated internodes. If the survey is conducted prior to bud set (July 15) the current year's growth is not included. Surveys conducted after July 15th will include the current year's growth. Assess a representative branch from the midpoint of the live crown (as determined in Step 1). Determine how many of the four internodes have greater than 50% undamaged needles. Damaged needles are defined as needles that are not green. In order for an internode to be considered healthy, more than half of the needles in that internode must be green. Determine the % healthy internodes by dividing the number of healthy internodes by 4 and multiply by 100. In cases where the number of healthy internodes varies from branch to branch at a given whorl choose a representative one. (ie. Do not attempt to pass (or fail) a tree by choosing an unrepresentative branch).

**Step 3. Estimate Extent of Foliage %**

Multiply the % Live Crown estimated in Step 1 by the % healthy internodes in Step 2, the product is the extent of Foliage. If this value **exceeds 20%** the tree is Free Growing, provided it passes all of the other Free Growing Damage standard criteria. In the case of trees attacked by **Dothistroma** needle blight this product must exceed **50%**.

*Dothistroma needle blight symptoms include a scorched appearance with most damage occurring at the base of trees and progressing upwards. On individual needles bright red bands typically form at the interface between damaged and green foliage. Fruiting bodies often form within these red bands and consist of small black ball-like structures that cause small rips and raised flaps in the epidermis of dead needles.

**Examples**




| a) | b) | c) | d) |
|---|---|---|---|
| 70% Live Crown | 50% Live Crown | 50% Live Crown | 50% Live Crown |
| 4/4 Healthy Nodes | 4/4 Healthy Nodes | 2/4 Healthy Nodes | ¼ Healthy Nodes |
| 70% X 100% | 50% X 100% | 50% X 50% | 50% X 25% |
| **= 70%** | **= 50%** | **= 25%** | **= 12.5%** |

2004-11-02

## Appendix 5: Sample Standards for Detection and Treatment for bark beetle

*Detailed Aerial Survey*

1. Spot infestation locations will be collected as point features. The species and number of (red) attack trees containing 3 or more IBM or 10 or more IBS will be entered.
2. Larger, continuous patch infestations will be collected as polygon features, and the percentage of year one and year two attack (red) trees in the polygon will be entered. These polygons will be generated at a collection rate of one point per second and provide as digital polygon data in shape file format.
3. GPS settings will conform to the Ministry of Forests, Lands and Natural Resource Operations GPS standards, except for a reduced masking angle of 10 degrees to reduce down time and increase satellite availability.
4. Map tracking software will be used during the detailed aerial detection flights to ensure adequate coverage. A shape file with the flight path will be provided within 72 hours of completion of the flight. Aircraft crew and GPS time will be included in this file.
5. The datum to be used will conform to the standards.

*Probing Specifications*

a) **RIBBONING AND ESTABLISHMENT:**

- GPS locate a POC to a known survey point or an aerial photo tie such as road and block junctions, creeks, etc. Mark the POC with a **blazed, painted, ribboned tree and metal tag** which states site number(s), date, bearing of first segment of line and crew person's initials.
- Survey lines will be clearly marked with designated probe ribbon at intervals not greater than 15 meters. Line junctions and bearing changes will be marked with **three ribbons**.
- At each infestation centre, a station will be established and GPS located. An unattacked tree shall be **blazed, painted, ribboned and metal tagged**. The tag shall indicate site number, distance from POC, number and classification of infested trees found, date, and crew's initials. On the painted blaze, the site number, and the number and classification of trees found shall be written in black felt pen.

b) **RECORDING**:

❖ Crews are responsible for noting the following information from survey lines on field traverse sheets:

- The distance and compass bearing of all access and survey lines,

- Site infestation centres (Waypoint ID),
- Location of treatment trees with respect to the infestation centre,
- Creeks and swamps,
- Blowdown,
- Percent of slope at 100 metre intervals, if more than 10%,
- Percent of slope at the centre of each infestation,
- Topography,
- Other pest activity,
- All field notes must be legible, have a POC, bearing change, UTM coordinates and any other pertinent information as required.

❖ Probe cards may be supplied to tally the status and number of trees found at each infestation site:
- All susceptible spruce trees within a **100 metre** radius of any red or green attack tree must be assessed for beetle activity,
- Other pest activity,
- Access problems for treatment types (i.e. fall and burn, logging etc),
- Recommended treatments,
- Average DBH, height, and volume.

❖ Level 1 CMT Recording Form shall be filled out should CMTs be encountered during the probing phase.

❖ Unmapped trees:
- Wherever unmapped trees are found along the line, a new infestation centre (Waypoint ID) shall be established. This new centre shall be GPS located in the same manner as indicated above and numbered with the same Waypoint ID, but alphabetically, (i.e. L082-198A, L082-198B etc.),
- All infestation sites must be tied into:
  -probe lines,
  -infestation centres (Waypoint ID),
  -POC or known survey point.

❖ All beetle attacked trees which are found in the survey will be classified and noted as follows:

| Attack | Code | Tree Characteristics |
|---|---|---|
| Pitch-out | P/O | Unsuccessful current attacked trees shown by external pitch tubes, pitch-filled galleries and no brood production. Trees have green foliage. |
| Current Attack | C/S1 | A tree which has been successfully attacked in the current year on more than 50% of the bole. Foliage is green. |
| Red Attack – Spruce | S2 | Yellow or red foliage; contains brood that is in their 2nd year cycle; may also contain 1st year brood |
| Grey Attack – spruce | G | No beetle or larvae present; 3 or more years after attack |

- ❖ All **current C/S1** and **S2** coded trees will be marked with a single fluorescent orange paint ring at DBH or higher and sequentially numbered to signify treatment required.
- ❖ All **G** coded trees will be marked with 2 fluorescent orange paint rings at DBH or higher to signify no treatment.
- ❖ Forked trees – a fork below DBH (1.3 meters) shall be considered two trees.
- ❖ Pitch-out trees shall be marked with "**P/O**" using fluorescent orange paint to show that they have been examined. Pitch-outs do not need to be sequentially numbered.
- ❖ Green trees, which have survived an attack, and have no evidence of remaining beetle or larvae, or have other pest activity shall be marked "**X**" to indicate that they have been inspected.
- ❖ Strip attack trees will be categorized as either **C/S1 or P/O**

c) **FINAL PRODUCT**:

- ❖ Digital submission of a 1:10,000 scale map plus shape files that show the following:
    - Accurate plotting and labelling of infestation centres (Waypoint ID), probe lines, POC and sites, complete with distances and bearings,
    - Other topographic information such as roads, terrain, swamps etc.,
    - Geographic location,
    - Air photo numbers,
    - UTMs
    - DBH and slope,
    - Mapsheet number,
    - Date and crew initials,
    - #C, #Y1, #Y2, #SBB,
    - Access.

- ❖ The contractor will submit a digital copy of a summary report (as directed by the Contract Officer) with at least the following information:
  - Mapsheet Number
  - Infestation site number (Waypoint ID),
  - Pest type,
  - Status and total numbers of trees found,
  - Average diameter (DBH),
  - Average Height,
  - Slope %,
  - Aspect,
  - Number of pre- or post- 1842 CMTs
  - Probe Date,
  - Crew Initials,
  - Timber Type,
  - Recommended treatment,
  - Comments.

*Discovery of Unexpected Features:*

If any archaeological sites or other resource-based infrastructure/activities are discovered during probing, it is the field person's responsibility not to move or damage the item(s) and to record the location and description of the item(s). The licensees designated supervisor must be notified immediately of any such discovery.

*Fall and Burn*

*Method*

- All **C/S1** and **S2** trees marked with a **single, orange paint ring** shall be felled, bucked into blocks, piled and burned up to a point three (3) metres beyond the last visible beetle entry hole or presence of larvae. The remainder of the tree shall be bucked into 2 foot sections to facilitate drying of the cambium.
- Upon the written direction of the Contract Officer, any **C/S1 or S2** that has **not been marked** or identified for treatment shall be bucked into blocks, piled and burned up to a point three (3) metres beyond and visible evidence of larvae under the bark. The remainder of the tree shall be bucked into 2 foot sections to facilitate drying of the cambium
- All trees scheduled to be piled and burned shall be burned so that all of the bark including the cambium layer is completely destroyed.
- Wherever possible, stumps shall be burned by locating burn piles on top of them.
- No stumps shall exceed 30 cm in height.
- All stumps of all marked trees shall be stripped of their bark to mineral soil unless burned.
- Fall and burn operations are to be carried out with minimal disturbance to the site and to non-infested trees.

- All burning activities may be suspended or restricted at any time due to burning bans. It is the Contractor's responsibility to be informed of the venting conditions each day by contacting the BC Environment Air Quality Information Line for the Skeena Region at 1-888-281-2992.

## *Pheromones*

### *Bait Placement on Trees*

1. Mark date and agency initials on bait.
2. Place baits in prescribed pattern at specified intervals unless advised otherwise.
3. Select large un-attacked healthy trees (greater than 20 cm dbh).
4. Place lure on north side of tree above understory and brush with minimum height of 2 meters above ground.
5. Clearly identify baited tree with flagging tape, consistent with Licensee's field marking SOP.
6. Do not place baits within riparian reserve or management zones of any riparian feature.
7. Do not place baits in areas that are not feasible to harvest.

## *Conventional Trap Trees for Spruce bark beetle*

- Trees should be felled between March and the end of April and removed by the following winter before they become covered with excessive snow and frozen in place.
- Sites should be clearly flagged and must be mapped to facilitate felling and subsequent harvesting.
- Trees must be uninfested, have a thick bark and large diameter. Limbs must be left intact so as to simulate natural blowdown.
- Where possible, fell trees into the direction that provides the most shade as possible without compromising the eventual skidding opportunities.
- Stumps must be 30 cm or less
- Do not buck or limb
- Trees should be felled as close to the infestation as possible and no farther away than 0.8 km.
- Fresh natural spruce blowdown may be incorporated into the site
- Trap tree patches are usually groups of 12-25 trap trees felled into shaded, standing timber adjacent to an all-season road to facilitate eventual skidding and hauling after the flight. Trap trees are much more effective in attracting beetles than pheromone baits and should be used whenever possible.

- Pre-felled road rights-of-way, landings, and cutblock strips can be used during pre-development as a large scale conventional trap tree program. Their sheer numbers can usually compensate for lack of ideal shading.

## Legacy Trees and Forest Management Operations

**What is a Legacy Tree?**

A Legacy Tree is a tree (usually lodgepole pine) that has been treated previously with the pesticide MSMA (trade name Glowon®) and is still on-site, either standing or felled. The purpose of the treatment was to kill the developing broods of mountain pine beetles in small and isolated infestations.

**Why the Concern about Legacy Trees?**

MSMA is an arsenical compound and recently there have been concerns that residual arsenic in legacy trees may be a risk to human health and to the well-being of the environment. Scientific investigations will be directed towards determining the extent and validity of these concerns. Legacy Trees are not to be removed from the forest or burned until the results of these investigations are complete.

**How Will Legacy Trees Affect Operations?**

Legacy Trees are to remain in place in the forest. They are not to be felled, removed or burned. They are to be conspicuously marked by whomever finds them, their extent and location recorded and that information reported to the district manager. Legacy trees can, in many cases, be incorporated into Wildlife Tree Patches, thereby minimising their impact upon harvesting operations.

**How Are Legacy Trees Identified?**

Legacy Trees were conspicuously marked at the time of their establishment.

MSMA-treated tree at time of establishment

Over time, however, flagging tape and tags may fall off, paint may fade and brush may cover the axe frill.

Legacy tree seven years after establishment

Sometimes all that will identify a standing dead lodgepole pine Legacy Tree may be the axe frill very low on the bole.

Axe frill at base of Legacy Tree

Spruce trees have, from time to time, been treated with MSMA to create lethal trap trees. The trees were felled two weeks after injection with MSMA so that they would be attractive to spruce beetles. These trees may be difficult to quickly identify as MSMA-treated trees due to decomposition. However, when groups of felled spruce trees are discovered in remote locations one should examine them carefully for axe frills and treatment tags.

**What Do I Do when I Find Legacy Trees?**

Agreement has been reached that, when Legacy Trees are discovered in the field, the person finding them will:

- record an approximate central point of the area, using a GPS
- record the extent and approximate boundary of the area covered by Legacy Trees
- determine and record the approximate date of treatment
- record the approximate number of Legacy Trees
- record the species of the Legacy Trees
- report this information to the district manager

**Where are Known Legacy Trees Listed?**

Information on known Legacy Trees is available from the district manager and it will be available through the website noted below.

**For More Information:**

http://www.for.gov.bc.ca/hfp/health/msma.htm

Or contact your district manager.

**Legacy Tree Reporting Form**

**GPS location** (degrees & decimal minutes)

_____N _____W

**Approximate Area** (hectares) (attach map)

_____ Ha

**Approximate Date of Treatment**

_____

**Approximate Number of Trees Treated**

_____

**Other Pertinent Information**

_____

_____

_____

_____

_____

**Submitted By:** **Date Submitted:**

_____ _____

## *SDM DAMAGE CRITERIA FOR EVEN-AGED (AGE CLASS 2 & 3) CONIFEROUS TREES (Revision 5).*

**PLEASE READ** the preceding introduction before using the following table and figures.

| LOCATION OF DAMAGE | TYPE OF DAMAGE | TREE BEING ASSESSED IS UNACCEPTABLE IF: | HOST SPECIES | LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES | COMMENTS |
|---|---|---|---|---|---|
| STEM | **Wound** (including sunscald and girdling) | • the tree has a girdling wound which is greater than 33% of the stem circumference, or<br>• the tree has a wound which is equal to or greater than 1m in length. | All | **Biotic causes**: bear AB, cattle AC, hare AH, moose AM, porcupine AP, squirrel AS, beaver AZ, atropellis canker DSA<br>**Abiotic causes**: sunscald NZ, logging TL, mechanical TM,fire NB, windthrow NW | A **wound** is defined as an injury in which the cambium is dead (e.g., sunscald) or completely removed from the tree exposing the sapwood. Measure the wound across the widest point of the exposed sapwood (or dead cambium when the tree is damaged by sunscald). Healed over wounds (=scars) are acceptable. |
| STEM | **Insect mining at root collar** | • the tree is currently attacked by a bark-mining insect such as a weevil or a beetle and exhibits symptoms such as foliage discoloration, thinning and/or reduced height growth increments | Pl, Sx | root collar weevil IWW, red turpentine beetle, IBT, lodgepole pine beetle IBL | Only trees that are symptomatic should be checked for insect infestation or mining damage. Non-symptomatic trees are presumed to be unaffected by insect mining. |
| STEM | **Deformation** (including crook, fork, browse, and dead or broken top) | • the pith is horizontally displaced more than 30 cm from the point of defect and originates above 30 cm from the point of germination, or | All | **Biotic causes**: Bear AB, cattle AC, deer AD, elk AE, moose AM, defoliators ID, spruce leader weevil IWS, lodgepole pine terminal weevil IWP, sequoia pitch moth ISQ,<br>**Abiotic causes**: frost NG, hail NH, snow NY, drought ND, logging TL, mechanical TM, Deep planting TP | For **horizontal displacement** see Figure 1. |
| | | • the tree has a fork in the lower 2/3 of the stem and the smaller of the stems is >¼ the diameter of the main stem, note forks below 1.3 m are considered as two trees, or | All | | For **forking**, see Figure 2. If unable to determine cause of fork record as damage code **K**, if cause of fork is clear record under appropriate damage code. Note: forks below 1.3 m are considered as two trees, both stems should be measured for dbh. |
| | | • the tree has a dead or broken top at a point that is >5 cm in diameter. | All | | |
| STEM | **Lean and sweep** | • the tree leans >30° from the vertical with or without growth correction (sweep) | All | flooding NF, snow NY, slides NS, wind NW, mechanical TM | |
| STEM | **Suppressed** | • the tree has a height to diameter ratio > 100<br>• or, tree has < 20% Live Crown | Pl, Py, Pw, Fd, Sx, Lw | Suppressed light environment, leading to high potential for competition induced mortality VT | **Note:** Only trees that are clearly not expected to reach rotation should be deemed unacceptable |
| STEM | **Infection** (including cankers and galls) | • any infection occurs on the stem, except DSG<br>• DSG stem gall affects >25% of stem circumference | All<br>Pl, Py | comandra blister rust DSC, stalactiform blister rust DSS white pine blister rust DSB, western gall rust DSG, | **Note**: Wounds caused by rodent feeding around rust cankers should have stem rust recorded as the causal agent. |

Revision 6: 11 June 2010

| LOCATION OF DAMAGE | TYPE OF DAMAGE | TREE BEING ASSESSED IS UNACCEPTABLE IF: | HOST SPECIES | LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES | COMMENTS |
|---|---|---|---|---|---|
| STEM | **Bark mining** | • Any of the following signs are visible: pitch tubes, boring dust, exit holes on bark surface, galleries under the bark | Pl, Sx, Fd | Douglas-fir beetle IBD, mountain pine beetle IBM, spruce bark beetle IBS, Ips pini IBI, *Pityogenes* & *Pityophthorus* IBP | **Note:** pitch tubes can be associated with trees that have successfully repelled bark beetles, bark must be removed above pitch tube to confirm successful attack (successful galleries will be filled with frass and **not** pitch, contain adult beetles and/or larval galleries).<br><br>Stressed trees are susceptible to secondary bark and twig beetles. |
| BRANCH | **Infection** (cankers) | • an infection occurs on a live branch less than 20 cm from the stem. | Pw, Pl, Py | white pine blister rust DSB, comandra blister rust DSC, stalactiform blister rust DSS | |
| BRANCH | **Gouting** | • any adelgid **gouting** occurs on a branch. | Ba, Bg, Bl | balsam woolly adelgid IAB. | **Gouting** is defined as excessive swelling of a branch or shoot caused by balsam woolly adelgid, and is often accompanied by misshapen needles and buds. It is most common on branch tips and at nodes near the ends of branches. Consult a recent distribution map to identify the geographic extent of this pest. |
| FOLIAGE | **Dothistroma** | • > 50% of tree foliage has been removed by Dothistroma in ICH, CWH, and SBS biogeoclimatic zones. | All P | Dothistroma needle blight, DFS | See Figure 3 |
| FOLIAGE | **Douglas-fir tussock moth and hemlock looper** | • >60% of tree foliage has been removed due to hemlock looper of Douglas-fir tussock moth. | Fd, Hw | Douglas-fir tussock moth (IDT), hemlock looper (IDL) | |
| FOLIAGE | **Other defoliating insects and disease** | • >80% of tree foliage has been removed due to foliage disease. | All other conifers Note: Lw | foliage diseases DF, defoliating insects ID | Note: Lw is a deciduous tree so defoliation has less impact. Repeated defoliation attacks will result in dead branches, apply the >80% rule to obviously dead branches, not just defoliated branches as with other conifer species<br>See Figure 3 |
| FOLIAGE | **Elytroderma needle cast systemic infection** | • The top 2/3's of the tree is affected and the growth is clearly stunted. | Pl, Py | Elytroderma needle cast DFE | Note: To confirm infection the surveyor must observe signs of the pathogen as small dark streaks on dead foliage |
| STEM OR BRANCH | **Dwarf mistletoe infection** | • Any layer 1 and 2 tree with a Hawksworth rating >3 (Figure 4).<br>• any infection occurs on the stem or a live branch of layer 3 trees.<br>• a susceptible tree is located within 2 times the height of the infection on an overtopping tree, which is infected with dwarf mistletoe. | Hw, Pl, Lw, Fd | Douglas-fir dwarf mistletoe DMF,hemlock dwarf mistletoe DMH, larch dwarf mistletoe DML, lodgepole pine dwarf mistletoe DMP, | **Note:** To confirm infection, the surveyor must observe mistletoe aerial shoots or basal cups on regeneration or on live or dead fallen brooms. **Overtopping tree** is a tree that is in an overtopping layer. |

| LOCATION OF DAMAGE | TYPE OF DAMAGE | TREE BEING ASSESSED IS UNACCEPTABLE IF: | HOST SPECIES | LIKELY DAMAGE AGENTS & DAMAGE AGENT CODES | COMMENTS |
|---|---|---|---|---|---|
| ROOTS | **Root disease** | • sign(s) or a definitive combination of symptoms of root disease are observed. | All | armillaria root disease DRA, blackstain root disease DRB laminated root rot DRL, annosus root disease DRN tomentosus root rot DRT. | **Signs** are direct evidence of the pathogenic fungus including fruiting bodies, distinctive mycelium or rhizomorphs. **Symptoms** include foliar chlorosis or thinning, pronounced resin flow near the root collar, reduced recent leader growth, a distress cone crop, and wood decay or stain. An individual symptom is not sufficient to identify a root disease. |
| | | • infected tree found in plot. See comments for well-spaced tree net down calculation. The multiplier for all root disease infected trees is 1. The well-spaced tree that is netted down is the susceptible species that is closest to the infected tree. Note that the WS tree that is netted down may vary depending on the species acceptability rules being followed, those currently used or those used at the time of declaration. | All | armillaria root disease DRA, | **Note:** All conifer species are considered susceptible. All broadleaf species are considered **not susceptible** for survey purposes only. |
| | | | Fd, Bg,Hw,Sx, Se, Lw | laminated root rot DRL. | **Note:** Cw, Pl, Pw, Py, and all broadleaf species are considered **not susceptible** for survey purposes only. |
| | | | Fd, Pl, Pw, Sx | black stain root disease DRB. | **Note:** All other conifers and broadleaf species are considered **not susceptible** for survey purposes only |
| | | | Se, Sx, Fd, Pl | tomentosus root rot DRT. | **Note:** Bg, Bl, Cw, Cy, Pw, Py, and all broadleaf species are considered **not susceptible** for survey purposes only. |
| | | | Ba, Hw, Ss, Fd | annosus root rot DRN | **Note:** Cw, Cy, Pw, Pl, Py, and all broadleaf species are considered **not susceptible** for survey purposes only. |
| | | | | | **Example:** How to apply net down for all root diseases.<br>If root disease-infected trees are found in the plot:<br>1. In the first sweep, determine the total number of healthy, well-spaced trees using the prescribed minimum inter-tree distance (MITD) (e.g., 12 trees);<br>2. In a second independent sweep, determine the number of well-spaced **infected** trees using MITD (e.g., 1 infected tree);<br>3. From the number of **susceptible** healthy well-spaced trees found in step 1, subtract the **number of well spaced infected trees.** The result (e.g., 11 trees) is the adjusted number of healthy, well-spaced trees tallied for the plot. |

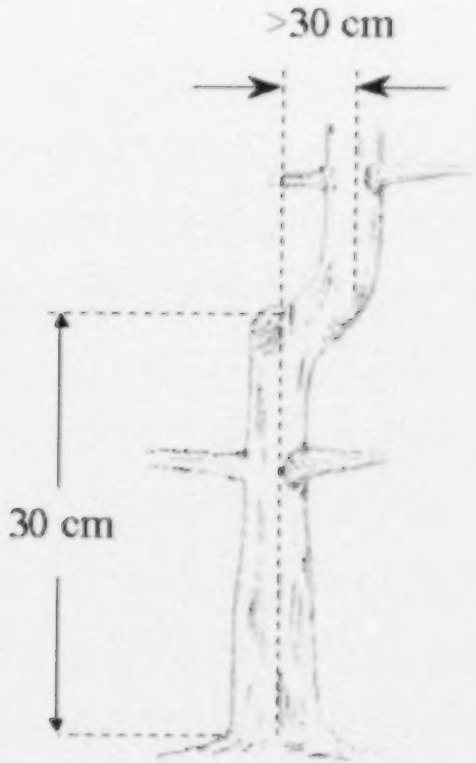



**Figure 1. Determining horizontal displacement when assessing stem deformation. This is only done when the tree has five seasons' growth after damage occurs.**

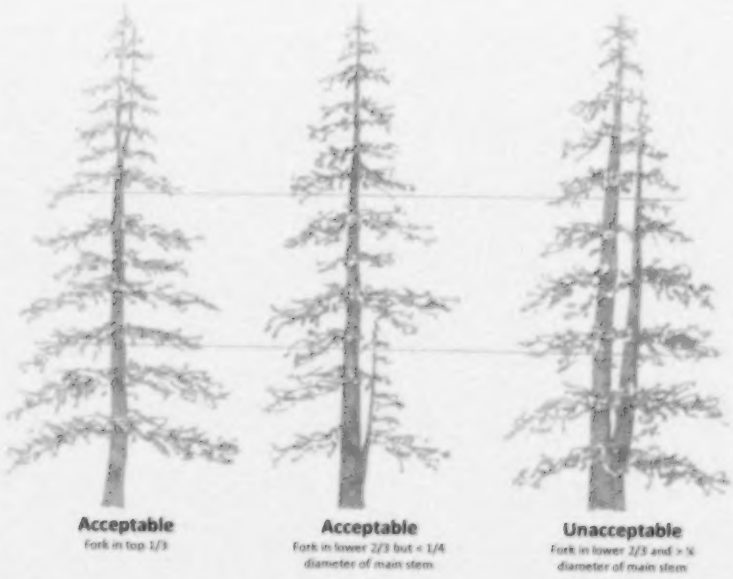
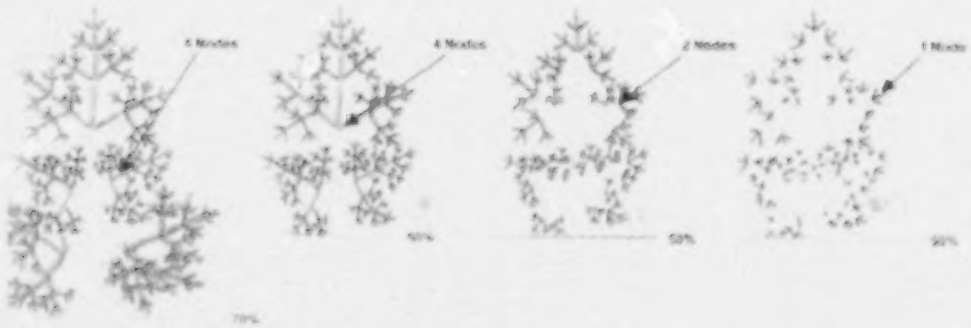



**Figure 2. Acceptable and unacceptable forking in age class 2 & 3 conifers (damage code K).**



a)
70% Live Crown
4 / 4 Healthy Nodes
70% X 100%
= **70%**

b)
50% Live Crown
4 / 4 Healthy Nodes
50% X 100%
= **50%**

c)
50% Live Crown
2 / 4 Healthy Nodes
50% X 50%
= **25%**

d)
50% Live Crown
1 / 4 Healthy Nodes
50% X 25%
= **12.5%**

**Figure 3. Calculating defoliation for Dothistroma-afflicted conifers.**

| Instructions | | Example |
|---|---|---|
| **Step 1** Divide live crown into thirds. | | If this third has no visible infections, its rating is (0). |
| **Step 2** Rate each third separately. Each third should be given a rating of 0, 1, or 2 as described below:<br>(0) no visible infections<br>(1) light infection (1/2 or less of total number of branches in the third infected<br>(2) heavy infection (more than 1/2 total number of branches in the third infected). | | If this third is lightly infected, its rating is (1).<br><br>If this third is heavily infected, its rating is (2). |
| **Step 3** Add ratings of thirds to obtain rating for total tree. | | The tree in this example gets a rating of: 0 + 1 + 2 = 3. |

**Figure 4. The Hawksworth six-class dwarf mistletoe rating system.**

Quick Reference:

1. Rows highlighted in yellow designate changes to preferred and acceptable species
2. Numbers formatted in **bold** font designate changes to species density and spacing

| | BEC Zones and Series | Regeneration | | | | | | Free Growing | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Preferred Species and (Free Growing Height) | Acceptable Species and (Height) | Target (sph) | Minimum Stocking (sph) | Minimum Preferred (sph) | Minimum Horizontal Distance (m) | Regen Delay (max years) | Target (sph) | Minimum Stocking (sph) | Minimum Preferred (sph) | Minimum Horizontal Distance (m) | Free Growing Delay (max years) | |
| | ESSFmc 01 | Bl(0.8) Sx(0.8) | Pl(1.6) | 1200 | 700 | 600 | 2 | 7 | 1200 | 700 | 600 | 2 | 20 | All ESSF Pli allowance: Further review necessary for mapsheets in the vicinity of 93L028, due to high disease noted in Pli on openings marked as SBSmc2, but likely ESSF mc. |
| | ESSFmc 02 03 | Pl(1.6) | Bl(0.8) Sx(0.8) | 1000 | 500 | 400 | 2 | 7 | 1000 | 500 | 400 | 2 | 20 | |
| | ESSFmc 04 | Pl(1.6) Bl(0.8) | Sx(0.8) | 1200 | 700 | 600 | 2 | 7 | 1200 | 700 | 600 | 2 | 20 | |
| | ESSFmc 05/06 | Bl(0.8) Sx(0.8) | | 1200 | 700 | 600 | 2 | 4 | 1200 | 700 | 600 | 2 | 20 | |
| | ESSFmc 07 | Bl(0.8) Sx(0.8) | Pl(1.6) | 1200 | 700 | 600 | 1 | 4 | 1200 | 700 | 600 | 1 | 20 | |
| | ESSFmc 08 | Bl(0.8) Sx(0.8) | | 1000 | 500 | 400 | 1 | 4 | 1000 | 500 | 400 | 1 | 20 | |
| | ESSFmc 09/10 | Bl(0.8) Sx(0.8) | | 1000 | 500 | 400 | 1 | 4 | 1000 | 500 | 400 | 1 | 20 | |
| >50% Pli | SBS dk 01 | Sx(1.0), Pli(2.0), Fdi(1.4)Lw(2.0) | | **2000** | **1600** | **1600** | 2 | 4 | **1600** | **1200** | **1200** | **2** | 20 | |
| | SBS dk 01 | Sx(1.0), Pli(2.0), Fdi(1.4)Lw(2.0) | | **1800** | **1400** | **1400** | 2 | 4 | **1400** | **800** | **800** | **2** | 20 | |
| | SBS dk 02 | PLI(1.4) | SX(.8) | 1000 | 500 | 400 | 2.0 | 4 | 1000 | 500 | 400 | **2** | 20 | |
| | SBS dk 03 | PLI(2.0)SX(1.0) | SB(1.0)Fdi(1.4)Lw(2.0) | 1200 | 700 | 600 | 2.0 | 4 | 1200 | 700 | 600 | 2 | 20 | |
| >50% Pli | SBS dk 04 | PLI(2.0) FDI(1.4) SX(1.0)Lw(2.0) | | **1800** | **1400** | **1400** | 2.0 | 4 | **1400** | **900** | **900** | 2 | 20 | |
| | SBS dk 04 | PLI(2.0) FDI(1.4) SX(1.0)Lw(2.0) | | **1600** | **1200** | **1200** | 2.0 | 4 | **1200** | **700** | **700** | 2 | 20 | |
| >50% Pli | SBS dk 05 | PLI(2.0) SX(1.0) | Lw(2.0)Fdi(1.4) | **2000** | **1600** | **1400** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS dk 05 | PLI(2.0) SX(1.0) | Lw(2.0)Fdi(1.4) | **1600** | **1200** | **1000** | 2.0 | 4 | **1400** | **800** | **700** | 2 | 20 | |
| >50% Pli | SBS dk 06 | SX(1.0),Fdi(1.4),Lw(2.0)PLI(2.0) | | **2000** | **1600** | **1600** | 2.0 | 4 | **1600** | **1200** | **1200** | 2 | 20 | |
| | SBS dk 06 | SX(1.0),Fdi(1.4),Lw(2.0)PLI(2.0) | | **1600** | **1200** | **1200** | 2.0 | 4 | **1400** | **800** | **800** | 2 | 20 | |
| | SBS dk 07 | SX(.8) Lw(2.0)Fdi(1.4) | PLI(1.4) | 1200 | 700 | 600 | 1 | 4 | **1000** | **500** | **400** | 1 | 20 | Fdi and Lw are pref on 07a but not at all on 07b |
| | SBS dk 08 | SX(1.0) | PLI(2.0) | 1200 | 700 | 600 | 1 | 4 | 1200 | 700 | 600 | 1 | 20 | |
| | SBS dk 09 | Pl(1.4) Sb(0.8)Sx(0.8) | | 400 | 200 | 200 | 1 | 4 | 400 | 200 | 200 | 1 | 20 | |
| | SBS dk 10 | Pl(1.4) Sb(0.8)Sx(0.8) | | 400 | 200 | 200 | 1 | 4 | 400 | 200 | 200 | 1 | 20 | |
| >50% Pli | SBS mc 2 01 | PLI(1.6) SX(.8)Fdi(1.4) Lw(2.0) | BL(.8) | **2000** | **1600** | **1400** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS mc 2 01 | PLI(1.6) SX(.8)Fdi(1.4) Lw(2.0) | BL(.8) | **1800** | **1400** | **1200** | 2.0 | 4 | **1400** | **800** | **700** | 2 | 20 | |
| | SBS mc 2 02 | PLI(1.2) | BL(.6) SX(.6) | 1200 | 700 | 600 | 2.0 | 4 | 1000 | 500 | 400 | 2 | 20 | |
| | SBS mc 2 03 | PLI(1.6) | BL(.8) SB(.8)SX(.8) Fdi(1.4)Lw(2.0) | 1200 | 700 | 600 | 2.0 | 4 | 1200 | 700 | 600 | 2 | 20 | |
| >50% Pli | SBS mc 2 05 | SX(.8), Lw(2.0)PLI(1.6)Fdi(1.4) | BL(.8) | **2000** | **1600** | **1400** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS mc 2 05 | SX(.8), Lw(2.0)PLI(1.6)Fdi(1.4) | BL(.8) | **1600** | **1200** | **1000** | 2.0 | 4 | **1400** | **800** | **700** | 2 | 20 | |
| >50% Pli | SBS mc 2 06 | SX(.8), Lw(2.0)PLI(1.6)Fdi(1.4) | BL(.8) | **2000** | **1600** | **1400** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS mc 2 06 | SX(.8), Lw(2.0)PLI(1.6)Fdi(1.4) | BL(.8) | **1600** | **1200** | **1000** | 2.0 | 4 | **1400** | **800** | **700** | 2 | 20 | |

| BEC Zones and Series | | Regeneration | | | | | | Free Growing | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Preferred Species and (Free Growing Height) | Acceptable Species and (Height) | Target (sph) | Minimum Stocking (sph) | Minimum Preferred (sph) | Minimum Horizontal Distance (m) | Regen Delay (max years) | Target (sph) | Minimum Stocking (sph) | Minimum Preferred (sph) | Minimum Horizontal Distance (m) | Free Growing Delay (max years) | |
| >50% Pli | SBS mc 2 06 | SX(.8), Lw(2.0)PLI(1.6)Fdi(1.4) | BL(.8) | **2000** | **1600** | **1400** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS mc 2 06 | SX(.8), Lw(2.0)PLI(1.6)Fdi(1.4) | BL(.8) | **1600** | **1200** | **1000** | 2.0 | 4 | **1400** | **800** | **700** | 2 | 20 | |
| | SBS mc 2 07 | SB(.6) SX(.6) | BL(.6) PLI(1.2) | 1000 | 500 | 400 | 1 | 4 | 1000 | 500 | 400 | 1 | 20 | |
| | SBS mc 2 09 | SX(.8) BL(.8) | PLI(1.6) | 1200 | 700 | 600 | 1 | 4 | 1200 | 700 | 600 | 1 | 20 | |
| | SBS mc 2 10 | SX(.6) BL(.6) | PLI(1.2) | 1000 | 500 | 400 | 1 | 4 | 1000 | 500 | 400 | 1 | 20 | |
| >50% Pli | SBS wk 3 01 | PLI(2.0) SX(1.0) | BL(1.0)FDI(1.4)Lw(2.0) | **2000** | **1600** | **1400** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | Lw/Fdi- circumesic- only on mid to upper slopes |
| | SBS wk 3 01 | PLI(2.0) SX(1.0) | BL(1.0)FDI(1.4)Lw(2.0) | **1600** | **1200** | **1000** | 2.0 | 4 | **1400** | **800** | **700** | 2 | 20 | |
| | SBS wk 3 02 | PLI(1.4) | BL(.8) SX(.8) | 1000 | 500 | 400 | 2.0 | 4 | 1000 | 500 | 400 | 2 | 20 | |
| >50% Pli | SBS wk 3 03 | PLI(2.0) FDI(1.4) SX(1.0)Lw(2.0) | | **2000** | **1600** | **1600** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS wk 3 03 | PLI(2.0) FDI(1.4) SX(1.0)Lw(2.0) | | **1600** | **1200** | **1200** | 2.0 | 4 | **1200** | **800** | **800** | 2 | 20 | |
| >50% Pli | SBS wk 3 04 | PLI(2.0) FDI(1.4) SX(1.0)Lw(2.0) | BL(1.0) | **2000** | **1200** | **1000** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | |
| | SBS wk 3 04 | PLI(2.0) FDI(1.4) SX(1.0)Lw(2.0) | BL(1.0) | 1200 | 800 | 700 | 2.0 | 4 | 1200 | 800 | 700 | 2 | 20 | |
| | SBS wk 3 05 | PLI(2.0) | SX(1.0) SB(1.0) | 1200 | 700 | 600 | 2.0 | 4 | 1200 | 700 | 600 | 2 | 20 | |
| >50% Pli | SBS wk 3 06 | PLI(2.0) SX(1.0) | BL(1.0)FDI(1.4)Lw(2.0) | **2000** | **1200** | **1000** | 2.0 | 4 | **1600** | **1200** | **1000** | 2 | 20 | Lw/Fdi- circumesic- only on mid to upper slopes |
| | SBS wk 3 06 | PLI(2.0) SX(1.0) | BL(1.0)FDI(1.4)Lw(2.0) | 1200 | 800 | 700 | 2.0 | 4 | 1200 | 800 | 700 | 2 | 20 | Lw/Fdi- circumesic- only on mid to upper slopes |
| | SBS wk 3 07 | SX(1.0) | BL(1.0)FDI(1.4)Lw(2.0)Pli(2.0) | 1200 | 700 | 600 | 1.5 | 4 | 1200 | 700 | 600 | 1.5 | 20 | Lw/Fdi- circumesic- only on mid to upper slopes |
| | SBS wk 3 08 | SX(.8) | PLI(1.4) BL(.8) | 1000 | 500 | 400 | 1.5 | 4 | 1000 | 500 | 400 | 1.5 | 20 | |

****Existing footnotes in reference guide apply to any given species. These will be added to this table later**

[i] http://www.for.gov.bc.ca/hfp/health/Strategy/Forest%20Health%20Strategy.pdf
[ii] http://www.for.gov.bc.ca/hfp/health/fhdata/ProvBBStrategy.pdf